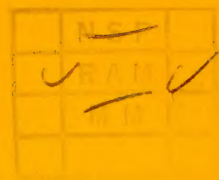


ANNUAL REPORT

1953

RUBBER RESEARCH INSTITUTE OF MALAYA



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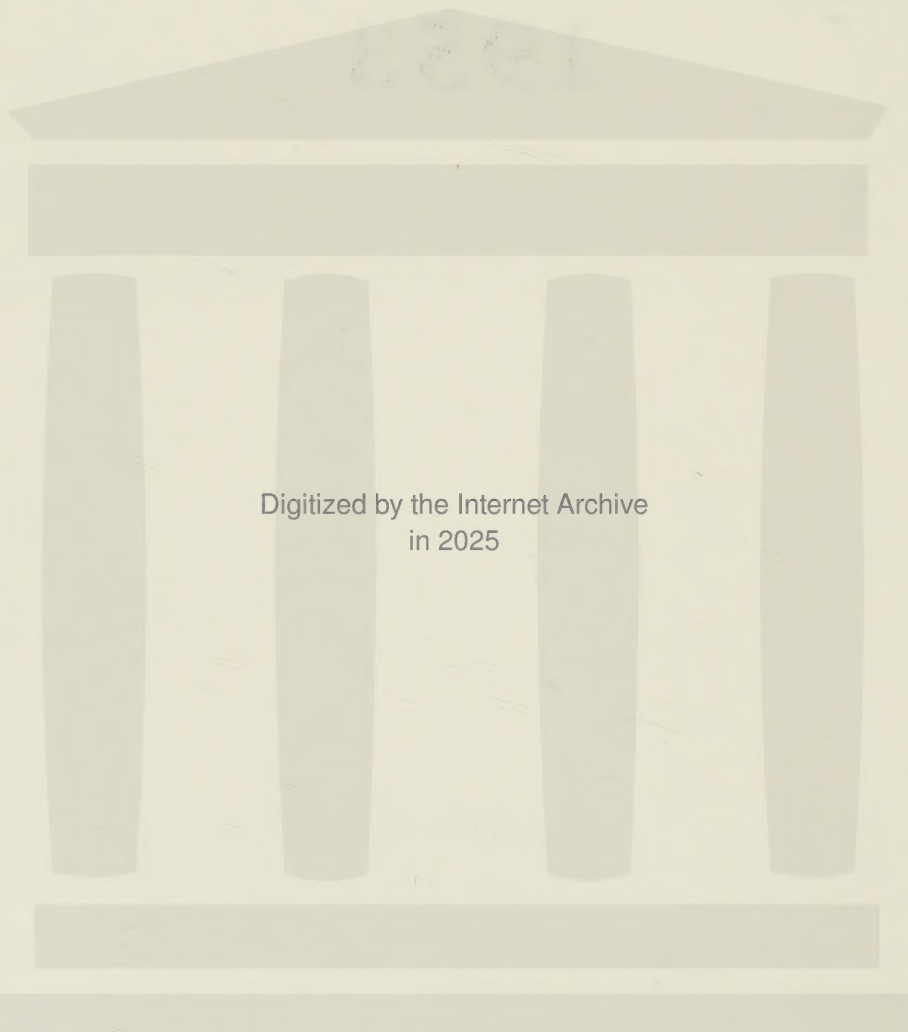
1953

Rubber Research Institute of Malaya

We are issuing back numbers of our *Annual Report* in a new format matching our *Journal*. The Director's reports have already been published, included in the annual reports of the United Planting Association of Malaya. Reports of Divisions, Sections, and the Experiment Station, have hitherto been given restricted circulation. Reports for 1955 and 1956 are in press and will shortly be issued, followed by the report for 1957.

RUBBER RESEARCH INSTITUTE OF MALAYA

ANNUAL REPORT
1953



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Report of the Board

Of the members appointed to serve on the Board of the R.R.I. for a period of three years from 1 September, 1952, few remained after the first half of 1953. By the tragic death of Mr Khoo Teik Ec, who was killed in the B.O.A.C. 'Comet' disaster at Calcutta on 2 May, the Board suffered a great loss. Mr A. V. Beith resigned his seat on the Board on his retirement from Malaya in June; Mr R. B. Carey resigned from the Board in August, and Mr H. H. Facer in November. Mr S. J. Nias resigned from the Board on leaving Johore for Selangor. Nomination of representatives to the panel and appointments to fill vacancies on the Board were delayed. At 31 December, 1953 the membership of the Board was:

- a The Director, R.R.I. Chairman of the Board (*ex officio*)
Mr C. E. T. Mann
- b The Secretary to the Treasury, Federation of Malaya. Mr V. E. Davies, O.B.E.
- c The Director of Agriculture, Federation of Malaya. Mr O. J. Voelcker, C.B.E.
- d Members appointed by the High Commissioner to represent the interests of smallholders:
The Hon'ble Tuan Haji Sheikh Ahmad bin Sheikh Mustapha, C.B.E., J.P.
Mr Fong Yeok Seng
- e Members appointed by the High Commissioner from a panel of twelve persons nominated jointly by the Rubber Growers' Association, the United Planting Association and the Malayan Estate Owners' Association:

Appointed	1. 9.53	Mr K. Arumugam
Appointed	1. 9.53	The Hon'ble Mr G. M. Knocker
Appointed	1.11.53	The Hon'ble Mr J. C. Mathison, O.B.E.
Appointed	1.11.53	Mr R. A. Coles
Appointed	1.12.53	Mr D. W. Hawkins

The Permanent Committee of the Board consists of two *ex-officio* members—the Director of the Institute and the Secretary to the Treasury, Federation of Malaya—and three other members appointed by the High Commissioner; at 31 December, 1953, these were—Tuan Haji Sheikh Ahmad, Mr O. J. Voelcker and Mr G. M. Knocker.

In the absence of Mr Knocker on leave in November and December, Mr S. J. Nias served on the Board and Permanent Committee.

During the year the Board held three statutory meetings and three special meetings; the Permanent Committee met six times and ad hoc Committees, on Estimates and Buildings, held three meetings.

During the absence of the Director on home leave, Mr C. G. Akhurst acted as Director, R.R.I., and Chairman of the Board and Permanent Committee, from 25 April to 14 October.

The year 1953 was the final year of operation of the plan for expansion of the programme of work and facilities at the R.R.I. under the Malayan Rubber Fund Five Years Plan, accepted by the producers and guaranteed by the Federation Government

in September, 1949. (See U.P.A.M. Annual Report for 1951—Section 13). During the year all vacant senior appointments provided under the plan were filled, completing the complement of 32 senior research and advisory officers (including the Director, Deputy Director and Smallholders' Advisory Officers) and 7 administration staff (Secretary, Assistant Secretary, and Manager and Assistants on the R.R.I. Experiment Station). The full complement of senior staff was reached about two years later than planned.

By the death of Mr C. C. T. Sharp on 17 March 1953, the Institute suffered a heavy loss. As Head of the Botanical Division and later as Deputy Directory, Mr Sharp had served the Board faithfully and with distinction. At the end of the year, of the senior research and advisory staff five only had served the Board before 1946.

All major capital developments, laboratory extensions, staff houses and extensions on the R.R.I. Experiment Station, were practically completed by the end of the year. The total cost of capital developments, estimated at \$1,714,000 in 1948, exceeded the estimated allowance by \$780,000. Against this, revenue from sales of rubber and planting material from the R.R.I. Experiment Station has exceeded expenditure on the Station over the period 1949-53 by approximately \$1,400,000. Profits have been paid into the Malayan Rubber Fund.

Subject to audit, the principal items are contributions from the Malayan Rubber Fund under the Five Years Plan:

1 Revenue expenditure	—	\$2,916,099
2 Capital expenditure	—	334,875

Surplus of revenue over expenditure on operation of the R.R.I. Experiment Station in 1952, paid to the Controller of Rubber in 1953, was \$103,000; on 1953 operations there is an estimated deficit of \$40,000.

During the year the Board considered proposals for a second five years period, 1954-58, to provide for consolidation of the R.R.I. establishment at about its present strength, with suggestions for some re-orientation of work and small increases in provision for expansion of work in certain directions, notably in application of mechanisation and the development of new types of natural rubber for special purposes. Plans were prepared in consultation with the British Rubber Producers' Research Association and the London Advisory Committee for Rubber Research (Ceylon & Malaya); the British Rubber Development Board was also consulted on certain aspects of the programme. The R.R.I. plans for 1954-1958 were submitted to the Controller of Rubber and the M.R.F. Advisory Committee, and also to the Rubber Producers' Council of the Federation of Malaya, in October 1953, to be examined together with similar plans submitted by the B.R.P.R.A. and the B.R.D.B.

In November, 1953, the M.R.F. Advisory Committee requested a re-examination of estimates for the year 1954 with a view to effecting an overall reduction of some 30 per cent in total expenditure. The Board submitted revised estimates in December, 1953; at the end of the year, plans for the continuation of the work of the Institute and estimates for the year 1954 were still under consideration.

C. E. T. MANN
Chairman of the Board

FEDERATION OF MALAYA

PAPER TO BE LAID BEFORE THE FEDERAL LEGISLATIVE COUNCIL BY
COMMAND OF HIS EXCELLENCY THE HIGH COMMISSIONER

MEMORANDUM BY THE ECONOMIC SECRETARY
ON A GUARANTEE TO THE MALAYAN RUBBER
FUND OF A FIVE-YEAR RESEARCH AND
DEVELOPMENT PROGRAMME

The British Rubber Producers' Research Association, the British Rubber Development Board, and the Rubber Research Institute of Malaya have prepared a joint memorandum setting out the composition, finances and functions of the various bodies concerned in rubber research and development, and making recommendations for a programme of research for the five years 1948 to 1952. In view of the unavoidable delay that has occurred in the consideration of the proposals it may now be more appropriate to consider the period 1949-1953 for the purpose of this memorandum. These recommendations have the support of the Colonial Office and have been unanimously supported by both the Malayan Rubber Fund Advisory Committee and the Malayan Rubber Advisory Committee. The former Committee at its fourth meeting on 12th February, 1949, expressed the opinion that in the interests of the rubber industry it was vital that the proposals for research and development presented in the memorandum should be put into effect at the earliest possible moment. A similar view was expressed by the Malayan Rubber Advisory Committee.

2. The British Rubber Producers' Research Association is financed by contributions equivalent to a cess of 1*d.* per 100 lbs. of rubber exported from British rubber producing territories, continuing the arrangement provided by the International Rubber Regulation Agreement, 1934-1944. From these receipts the British Rubber Producers' Research Association allocated 20 per cent. to finance the British Rubber Development Board. The contribution of the Federation of Malaya in 1948 was \$554,949. This sum was paid from the Malayan Rubber Fund. Since the war however, certain territories formerly included in the group of British rubber producing territories under the International Rubber Regulation Agreement have ceased to contribute on the 1*d.* per 100 lbs. basis on exports. The present position is that Sarawak has continued to contribute and remitted a sum of £3,722, based on 1*d.* per 100 lbs. rubber exports of nearly 40,000 tons in 1948; no contributions have been received from Burma and the Colony of North Borneo since 31st January, 1942; India has not contributed since 30th April, 1944, and Ceylon has not contributed since 30th September, 1946. The Ceylon Government has further notified the British Rubber Producers' Research Association of their intention to discontinue contributions as from 1st January, 1949.

3. The Rubber Research Institute is financed by grants from the Malayan Rubber Fund on the basis of annual estimates approved by the Board of the Rubber Research Institute. In 1948 the cost of the Rubber Research Institute borne by the Malayan Rubber Fund was \$1,691,118.

4. The Malayan Rubber Fund was constituted by the Rubber Regulation Enactment F.M.S. No. 37/36 and similar legislation in the Straits Settlements and Unfederated Malay States. The Fund is financed

by a cess of .25 of a cent per pound of rubber exported from the mainland; in Penang the cess is collected through an excise duty. Pre-war the Settlement of Singapore contributed. Since the end of the war, however, there has been no legislation in force in the Colony of Singapore to collect any equivalent of the cess imposed in the Federation. A bill has recently been drafted to impose a surcharge on rubber estates in Singapore calculated to be the equivalent of the cess in the Federation, and contributions will be resumed when the Bill becomes law. The 1948 income of the Fund was \$3,890,507.

5. The objects to which the Fund may be devoted, as provided by 16 (v) of the Federated Malay States Enactment No. 37/36 are:

- (a) the payment of the expenses of or connected with the administration of rubber regulation in Malaya and of purposes related thereto;
- (b) the payment of such expenses of the International Rubber Regulation Committee as the Government of the Colony, the Government of the Federated Malay States and the Government of any Malay State are liable to contribute;
- (c) the payment of contributions to the Rubber Research Institute of Malaya;
- (d) the furtherance of rubber research, the improvement of the rubber industry and the support of propaganda relating to rubber.

Expenditure under (a) has now fallen to the maintenance of a nucleus staff maintained by the Controller of Rubber amounting to about \$25,000 a year. Under (b) is paid a contribution to the International Rubber Study Group which amounts to about \$6,000 a year. Under (c) and (d) are made the payments for the cost of the Rubber Research Institute and the British Rubber Producers' Research Association and the British Rubber Development Board.

6. In addition to the present items of expenditure from the Malayan Rubber Fund, there is a proposal sponsored by the Malayan Rubber Advisory Committee to establish locally a Rubber Secretariat to safeguard the interests of the Malayan rubber industry and to provide an organization for effective Malayan representation at International level. If this proposal is approved, the estimated cost will be about \$120,000 a year.

7. It is essential that the programme of research recommended by the British Rubber Producers' Research Association, British Rubber Development Board and Rubber Research Institute should be guaranteed for a minimum period of five years. The financial position is summarised in the attached statement. It will be seen that the estimated expenditure to be met from the Fund exceeds the estimated income and that this income is based upon an annual export of 600,000 tons of rubber. Rubber exports from the Federation totalled 698,000 tons in 1948, but it is estimated that there will be a reduction to about 650,000 tons in 1949 due to the incidence of replanting and the end of flush yields. Should the price of rubber fall during the next five years, as it well may, production will probably decline.

8. On 31st December, 1948, there was an accumulated balance in the Fund of \$4,700,000. This will be required partly to meet capital expenditure on research which is estimated to cost not less than \$2,150,000. The balance should be retained as a reserve in order to guarantee the annual expenditure through any period when exports fall below the estimate. The estimates submitted by the Rubber Research Institute do not provide for the cost of maintaining the Rubber Research Institute's Experiment Station because the revenue from the Station, derived from sales of rubber and

planting material, approximately balances the present rate of recurrent expenditure on the Station. In the event of a fall in the price of rubber this position could not be maintained and it would appear reasonable to meet the resulting fall in revenue, and consequent increased cost of the experiment station, from reserve funds. A decrease of 100,000 tons a year in exports of rubber will cause a loss of \$560,000 a year in income to the Fund at the present rate of cess of .25 of a cent per lb. Thus the accumulated balance of \$2,550,000 (remaining after providing for the liability for capital for research, but not providing for a possible decline in revenue from sale of rubber by the Rubber Research Institute) will cover a fall in exports of 100,000 tons for nearly five successive years or a fall of 200,000 tons for over two years.

9. The probable income of the Malayan Rubber Fund will fall short of the expenditure to be guaranteed by some \$1,200,000 per annum over the five-year period. To meet this difference, the Malayan Rubber Fund Advisory Committee considered increasing the present cess of .25 of a cent a lb. On an annual export of 600,000 tons of rubber an increase to .30 of a cent a lb. would increase the income of the Fund by \$672,000 to \$4,032,000 a year; and an increase to .33 of a cent a lb. would increase the income by \$1,075,200 to \$4,435,200 a year.

10. The Malayan Rubber Fund Advisory Committee, however, was not prepared in view of the present high incidence of taxation on the rubber industry to recommend any increase of the present rate of cess.

11. The Committee recommended that since the future of the rubber industry is vital to the marketing interests in Singapore and the other ports of export, the matter of a contribution from those interests should be explored. In this connection, however, it must be remembered that any contribution levied upon the rubber market or dealers will almost inevitably be passed on to producers. It is, therefore, unlikely that any substantial contribution can be obtained in this way.

12. The Malayan rubber industry is patently of paramount importance to Malaya and to the Government of the Federation, and is the greatest single factor in the commerce and prosperity of Singapore. Its survival may well depend on successful research and energetic development. It is, therefore, necessary to ensure that the proposed five-year programme can be carried out. It is recommended that this should be done by the two Governments equally guaranteeing the programme set out in the financial summary attached to this memorandum for five years, subject to the first \$2,000,000 of the deficit falling on the Rubber Fund. If this is done, it will be necessary for the Government to review the situation (but not the guarantee) annually in order that, if it appears that there is a likelihood of Government having to make a payment on this account, the payment can be spread and not allowed to fall in the last two years.

13. This proposal is acceptable to the Controller of Rubber and the Advisory Committee of the Malayan Rubber Fund. The proposal has been considered by the Standing Committee on Finance, which has advised that the Government of the Federation should give this guarantee to the Malayan Rubber Fund accordingly on the understanding that the guarantee is shared equally by the Government of Singapore.

14. The Government of Singapore has been asked to agree to share the proposed guarantee equally with the Federation.

NOTE.—

.25 cent a lb.	=	\$5.60 a ton.
.30 cent a lb.	=	\$6.72 a ton.
.33 cent a lb.	=	\$7.392 a ton.

FINANCIAL SUMMARY FIVE-YEAR PERIOD 1949-1953

INCOME		EXPENDITURE	
	\$		\$
Federation—Cess at .25 of a cent a lb.= \$5.60 a ton on 600,000 tons= \$3,360,000 for five years, 1949-53	16,800,000	Controller of Rubber's Office @ \$25,000 p.a. ...	125,000
Singapore Contribution Estimated @ \$16,500 p.a.	198,000	Rubber Study Group \$6,000 p.a. ...	30,000
Balance being Excess of Expenditure over Income	5,897,000	Rubber Secretariat in Malaya @ \$120,000 p.a. ...	600,000
		Rubber Research Institute—	
		1949 ... £ 212,000 ...	\$ 1,817,144
		1950 ... 246,000 ...	2,108,571
		1951 ... 272,000 ...	2,331,428
		1952 ... 283,000 ...	2,425,714
		1953 ... 320,000 ...	2,742,857
		Total ... £1,333,000 ...	\$11,425,714
			11,425,714
		B.R.P.R.A. & B.R.D.B.—	
		1949 ... £ 210,000 ...	\$ 1,800,000
		1950 ... 230,000 ...	1,971,429
		1951 ... 250,000 ...	2,142,857
		1952 ... 270,000 ...	2,314,386
		1953 ... 290,000 ...	2,485,714
		Total ... £1,250,000 ...	\$10,714,286
			10,714,286
	22,895,000		22,895,000

NOTE.—No account has been taken of interest on the accumulated balance of the Fund, which was \$60,000 in 1948 and will be more in 1949.

Report of the Director

The year 1953 was the last year of operation of a five years plan for the expansion of the establishment and work of the Institute. The programme for the Rubber Research Institute formed a part of the Malayan Rubber Fund Five Years Plan 1949 to 1953, accepted by the industry and financed from the proceeds of a cess of a quarter of a cent a pound on rubber produced and exported from Malaya. Funds for major capital expenditure were provided from the reserves of the Malayan Rubber Fund. The Government of the Federation of Malaya provided a financial guarantee for the entire programme on the terms set out in Legislative Council Paper No. 40 of 1949. For convenience in reference this paper is enclosed with this report.

The Board's plan to build up the establishment of the Institute and to provide additional facilities for research and advisory services were completed by the end of 1953 in accordance with the programme approved in 1949. Apart from unforeseen increases in the cost of capital developments, the plan has been completed within the limits of the funds provided in the Malayan Rubber Fund five years programme.

The cost of the five years programme of the R.R.I. is briefly reviewed below.

a Annually Recurrent Expenditure

Year	Estimated provision \$	Contributions received	
		from the M.R.F. \$	others* \$
1949	1,817,144	1,817,144	
1950	2,108,571	2,052,063	3,700
1951	2,331,428	2,249,959	72,989
1952	2,425,714	2,264,557	42,525
1953	2,742,857	2,832,759	86,900
		11,216,482	206,114
Totals	\$11,425,714	\$11,422,596	

* Colony of North Borneo, Sarawak and Nigeria.

b Capital Expenditure: 1949-1953

Provision from the M.R.F.

By Council Paper No. 40 of 1949	1,714,000	
Supplementary provision approved by the Controller of Rubber and the Advisory Committee, Malayan Rubber Fund	880,913	
		\$2,594,913

Expenditure and Commitments

Laboratory extensions	706,123	
Staff quarters	694,639	
Factory, plant & equipment	447,406	
R.R.I. Experiment Station new land, extensions and upkeep of immature areas, labourers' quarters and miscellaneous building	577,799	
Commitments at end 1953	148,423	
		<u>\$2,574,390</u>

c Cost of Operation of the R.R.I. Experiment Station

Year	Deficit \$	Surplus \$	Net surplus \$
1949	120,819		
1950		665,351	
1951		755,034	
1952		103,773	
1953		18,438	
	<u>120,819</u>	<u>1,542,596</u>	<u>\$1,421,777</u>

Note

Under the provisions of the Malayan Rubber Fund Five Year Plan the R.R.I. Experiment Station was regarded as a self-supporting unit, of which the cost of operation would be provided out of revenue derived from sales of rubber and planting material. In the event of a loss on operation the deficit would be met from reserves of the Fund. No provision was made for disposal of profits from the Experiment Station although in fact these have been paid into the Malayan Rubber Fund.

d Financial Summary — 1949-1953

	Provision \$	Expenditure \$	Surplus \$
Totals.			
(a) Annually recurrent expenditure	11,425,714	11,422,596	3,218
(b) Capital expenditure	2,594,913	2,574,390	20,523
(c) Cost of operation of Experiment Station	—	—	1,421,777
Balance of income over approved expenditure			<u>\$1,445,518</u>

Staff

The rate of appointment of staff for the programme of work envisaged in the five years plan has not been possible in complete accordance with the plan. From the nature of its work the Institute depends very largely on the recruitment of fully qualified staff for senior posts, and the rate of expansion has therefore depended on the appointment of specialist staff. The original plan provided for appointments to all senior posts before the end of 1951; at the end of that year there were eight vacancies; at the end of 1952 there were six vacancies, but during 1953 all posts were filled. With three exceptions appointments to the senior staff were filled by advertising vacancies in the United Kingdom and British Commonwealth Territories. Candidates

for appointment were examined by a Selection Committee of the London Advisory Committee for Rubber Research (Ceylon and Malaya). The Committee also arranged for courses of advanced training for three officers required to fill specialist appointments.

In March 1953 the post of Deputy Director fell vacant with the sad death of Mr C. C. T. Sharp. Mr C. G. Akhurst was appointed to act as Deputy Director and was confirmed in that appointment in December 1953. Mr G. Owen was appointed Head of the Soils Division, succeeding Mr Akhurst in that post.

The Director, Mr C. E. T. Mann, was absent on long leave in Great Britain from 27 April to 14 October; during his absence Mr C. G. Akhurst acted as Director of the Institute and Chairman of the Board.

Particulars of all graduate staff appointments are given in the Appendix.

The full staff complement at the end of 1953 is summarised in the table below.

Summary of Staff appointments by Divisions and Sections at the end of 1953

Division or Section	Senior staff	Laboratory, Field and Clerical Staff	
	(Engaged on Agreement) Research & Administration	(Engaged by letters of appointment) Graduate Assistants	Assistants
i Administration	4 (1)	—	36
Statistician's Section	1	1	2
Soils Division	4	(2)	27
Botanical Division	6	2	26
Pathological Division	4	2	13
Chemical Division	12	4 (2)	60
ii Smallholders Advisory Service	3	—	3 (a) 39 (b) 33 (c)
R.R.I. Experiment Station	4	—	10
iii Totals	38	9	249

Figures in brackets indicate vacancies.

Notes

(i) Administration includes the posts of Director, Deputy Director, Secretary, Assistant Secretary, Publications and Information Section, Library and all general services (excluding artisans and daily paid staff).

(ii) The Smallholders Advisory Service Assistant staff includes

(a) Superintendent Rubber Instructors

(b) Rubber Instructors

(c) Rubber Demonstrators and clerical staff.

(From April 1953 all Superintendent Rubber Instructors and seven Rubber Instructors were seconded for full time duties with the Rubber Industry (Replanting) Board, Fund B).

(iii) Of the total of 38 senior staff in 1953, 27 were research and advisory officers of whom three only were in the Board's service in 1941.

SOILS DIVISION

Investigations relating to the survey of soils on which rubber is grown were rounded off and no further survey work is planned. The Provisional Classification of Malayan Soils — Communication 274, *Journal of the Rubber Research Institute of Malaya* 13 (1951) 20—provides a sound basis for our present needs. Future work will be confined to the study of any exceptional profiles encountered in soils where rubber is growing.

Observations in 1953 confirm a lack of growth response to fertiliser by young immature rubber on coastal alluvial soils. For mature rubber a significant improvement in growth in response to manure has been demonstrated — in one area due to nitrogen, and in the other due to magnesium lime, based on records taken 3 years after the commencement of the manuring programme.

Yield records from 22 out of 31 experiments, individually analysed, show no response to fertilisers in the period up to 3 years from commencement of the manuring programme. The remaining 9 experiments showed a probable beneficial effect from either nitrogen or phosphate in 5 cases, while a positive response to nitrogen was confidently established in 1 experiment and to phosphate in 3 experiments.

A tentative conclusion drawn from results to date is that young mature rubber on inland soils where the trees are normal in appearance is likely to show little or no increase in yield within 3 years of commencing a programme of biennial applications of fertilisers.

The need to recognise the limited value of early short term results is emphasised. Rubber is a long term crop and it is essential that manuring experiments should be continued for several years before a reliable assessment of the value of manuring can be made. Lack of positive beneficial results cannot be accepted as an indication that manuring at this stage may not have been necessary.

No indications have been found of specific clonal reactions to fertilisers although clone PB 86 may respond to Mg rather more markedly than other clones.

Evidence was obtained suggesting that phosphate and nitrogen manuring improved seed production.

Chemical weed killers were tested for controlling weeds in nurseries of rubber seedlings, but without success. C.M.U. (chlorinated methyl urethal) gave the best results but severely damaged rubber seedlings planted after spraying.

Lalang control tests, made by spraying with a number of proprietary weed killers, showed that sodium trichloroacetate was the most effective, but when applied at the rate of 50 or more pounds per acre it caused defoliation and dieback of the rubber trees growing in the area.

Preliminary tests with Krilium on heavy clay soils improved the permeability in soils containing more than 30 per cent clay.

The nutrition of hevea has been further investigated; satisfactory procedures for determination of potassium, iron, manganese, zinc and boron were developed and the *Aspergillus niger* technique for determination of molybdenum was studied. Methods for determination of sugars in lamina of rubber leaves by a chromatographic technique were successfully developed and glucose, fructose, sucrose and inositol were found to be always present in rubber leaves.

Report of the Director

The best time for sampling rubber leaves was judged to be between 0800 and 1000 hours. Interclonal differences and seasonal fluctuation in certain mineral contents of leaves, rubber content of leaf stalks and chlorophyll content of lamina were demonstrated on clones Tjir 1, RRIM 501 and PB 86.

A satisfactory nutrient solution for growing hevea in sand cultures has been developed and studies were commenced of the inter-relationships of Mg, K and P in the nutrition of the rubber tree when supplied to the rubber tree at different levels. Systematic study of visual symptoms of deficiency of several nutrient elements has been undertaken and the deficiency symptoms have been recorded.

In the plantation industry throughout Malaya little interest was shown in the manuring of old unselected seedling rubber trees for which replanting is the only satisfactory course. Despite the lack of conclusive experimental evidence it is becoming a common practice to use fertilisers for young high yielding rubber from the time of commencing tapping, the objective being to maintain high yields and to postpone the need to reduce tapping intensity.

The sharp decline in yield which is often observed when tapping on bark of second renewal of old bud-grafted rubber aged 20-30 years, suggests that, had the general vigour of the trees in this age group been maintained by regular manuring, then the need for reducing tapping intensity might have been delayed for several years and high yields maintained over a longer period.

Much of the advisory correspondence and the resulting visits to estates related to modifications of standard schedules of manuring and to the use of more economic methods of weed control by spraying and mulching procedures.

BOTANICAL DIVISION

Tjir 1, PB 49 and AVROS 157 were used in the 1953 breeding programme crossed with a number of the older proved clones reported from Indonesia and Indochina to be good seed parents. Included in the series were clones RRIM 513, 527, 603 and 616. 17,000 pollinations were carried out and 376 fruits were harvested. A success of 2.2 per cent was obtained.

The search for a method of early prediction of yield of seedlings and young buddings continued. A method of preliminary test (PT) has been initiated on hand pollinated seedlings and buddings derived from them. A re-examination of Gunnery's findings of the constant relationship between high yield and large sieve tubes (and large latex vessels) has been undertaken on a range of legitimate seedlings and derived buddings. Significant differences in mean sieve-tube diameter have been found between families.

New clones were established in 1953 from the RRIM collections of some 600 seedlings of hevea, including seedlings of *Hevea benthamiana*, *H. spruceana*, *H. pauciflora*, and new strains of *Hevea brasiliensis* obtained from different regions in South America.

Seventeen new clones developed in tropical America and believed to be resistant to the fungus *Dothidella uli* were successfully established. These were obtained by exchange with Brazil; the budwood was introduced after quarantine at the U.S.D.A. Plant Introduction Garden at Coconut Grove Florida through the Commonwealth Mycological Institute at Kew. Additions to the collection of promising clones were some 30 received in various small scale exchanges with other research organisations.

The large scale trial of the RRIM 500 series was tapped on renewed bark for the year. The highest yields recorded in pounds per acre per annum were: RRIM 501 - 2219, RRIM 513 - 2031 and RRIM 526 - 2179.

In the original small-scale trials of the RRIM 600 series clones the majority of the clones selected in 1949-50 continued to show satisfactory increases in yield. In the large scale trials RRIM 603, 613, 621 and 623 are vigorous.

With the completion of the first large scale trial of the RRIM 600 series clones on the R.R.I. Experiment Station, additional trials were established on estates. By the end of 1953 trial plots of new clones had been established on 81 estates.

Experiments designed to improve budding technique have achieved some success. A method of budding very young seedlings 6 to 8 weeks old has been worked out. Trials of hormone preparations to stimulate root formation indicate some value in such treatments in reducing transplanting losses.

A density and spacing experiment to compare wide hedge planting at 50ft, 65ft and 80ft with stands of 150, 195 and 245 trees per acre with standard forms of avenue planting giving 180 trees per acre, has been established, the clones used being RRIM 501, 513, 527 and LCB 1320.

From the results of experiments that have been continued over the past 8 years on mature trees the economic advantages of full circumference tapping are clearly established. Further investigation is required. Girthing rate is less in such systems.

Smallholders commercially practice daily tapping on 1/3 circumference; owing to wet days and for other reasons rarely are there more than 24 tapping days per month. Tapping of a replanting of buddings of Tjir 1 and Phil B84 on a smallholding began in 1949 to compare C/2.d/2.100 per cent with C/3.d/1.24d/30.107 per cent. This latter system over 5 years shows an overall advantage in yield of 18 per cent with slightly higher bark consumption. No difference in rate of growth of the trees was detected.

An experiment on old seedling trees every fourth day on two half circumference V cuts in virgin bark above the old tapping panels and one V cut in renewal bark plus yield stimulation on the high cuts resulted in a yield increase of 200 per cent during the first year of operation. Other experiments have confirmed that a moderate increase in tapping intensity plus the use of yield stimulants generally results in the maximum economic return from drastic tapping in preparation for replanting.

During 1953 a few estates with budded trees over 25 years of age on which tapping had reached the third tapping cycle resorted to ladder tapping in virgin bark at 80 to 90 inches above the union. Yields at the high level were about equal to those obtained at the period of maximum production several years previously when tapping was at normal levels.

The oldest experiments, on mature budded trees and clonal seedlings, continued using a yield stimulant containing 1 per cent of the normal butyl ester of 2,4,5-trichlorophenoxy-acetic acid in a formulation of palm oil and petroleum, applied at intervals of 6 months to a lightly scraped strip of bark below the tapping cut. During the first two years increased yields of 40 to 50 per cent were obtained. Tapping of treated and untreated trees has been on the C/2.d/2.100 per cent system throughout. For the present, a standard formulation for a suitable yield stimulant, based on 2,4,5-T has been issued for general use.

Experiments commenced to test the effect of certain growth promoting substances on rate of bark renewal. It appears that callus formation and later the activity of a

cork phellogen may be stimulated, so that there is an apparent improvement in bark renewal. The vascular cambium is not stimulated and the latex bearing tissues are not affected. An incidental observation made in the course of these experiments was that applications of 2,4,5-T to the young renewing bark above the tapping cut showed remarkable increases in yield.

A study of the ecological distribution of hevea has been undertaken chiefly in relation to the incidence and further study of South American leaf blight and the introduction of species and varieties likely to be of value in the future development of the breeding and selection programme.

Ecological surveys on new areas in course of development from jungle at Sungei Buloh have been made. Systematic ecological studies of the use of leguminous cover plants, indigenous plants with particular attention to grasses have been started.

PATHOLOGICAL DIVISION

Two large scale field experiments are in progress, laid down in 1950 and 1951, designed to answer many practical problems in relation to root disease and replanting. In one of them the experimental plots have been divided in half to allow a further comparison to be made — between complete and partial eradication of sources of infection — in the course of subsequent rounds of treatment.

In the course of other investigations bearing on root disease problems it has been shown that filtrates of cultures of *Botryodiplodia theobromae* are antagonistic to *Fomes lignosus* in culture. Observations on buried pieces of root infected with the major root parasites, to see how long they remain viable, have been continued to the thirtieth month. Legume cover crops planted in nursery beds have been inoculated with the root diseases of rubber, to establish their susceptibility to infection. New evidence has been found to show that spores of *F. lignosus* can infect the stumps of felled rubber trees.

The main subjects of enquiry by correspondents were: the control of root disease in young rubber; root disease in relation to replanting, and the identification of the root parasites. The important observation has been made that white root disease can spread to young rubber trees from legume creepers that are allowed to grow freely round the trees. The bark at the collar is quickly penetrated and killed. A few cases were seen of root disease due to *Poria hypobrunnea* spreading from stumps of thinned-out trees.

Five fungicides were submitted to preliminary *in vitro* and bark burning tests, but there was insufficient disease for field tests against mouldy rot. It has been found that fungicidal treatment of trees infected with black stripe should be continued into the dry season until the disease clears up. There is little advantage in stopping tapping. Surgery is useful only to get rid of any large burrs that have formed on the panels.

Dusting with sulphur is not needed to combat secondary leaf fall due to *Oidium*, which has been of little significance, but it may be economic to protect flowers in seed gardens. There was an unusual amount of late wintering, followed by some leaf fall due to *Gloeosporium*. In several places the weather conditions must have particularly favoured *Gloeosporium* leaf disease, which caused severe defoliation of trees three to seven years old.

Two further aerial spraying experiments with defoliants have been carried out with the boom and nozzle equipment used in 1952. The first was to compare one, two and three applications of normal butyl 2,4,5-T at three concentrations in diesel fuel oil. The second experiment was to see how well the spraying technique, worked out over flat land, could be applied in hilly country.

Branch dieback has been seen on young seedling trees and clone Gl 1 following defoliation brought about by leaf disease after wintering; two fungi associated with the dieback have been isolated. Enquiries reveal a steadily increasing amount of pink disease, ascribed to the increasing acreage of young rubber which alone is noticeably damaged by this disease.

Control measures against pink disease have been tested in conditions favourable to the fungus. Asphalt/kerosene mixture containing 5 per cent of a wood preservative, long recommended as a wound dressing, has been found to be not active enough as a treatment for pink disease. The best materials are Bordeaux mixture, and Fylomac 90 at a concentration of 0.5 per cent.

Because the control measures that have been applied against termites have been repellent in their action rather than poisonous, some purely repellent substances have been tested. The results were disappointing, and tests were discontinued when it was found that the new fungicides chlordane, aldrin and dieldrin gave very promising results.

Malformations that have been produced experimentally on seedlings infested with *Planococcus citri* resemble the symptoms suspected as being caused by this Coccid.

A spontaneously emulsifying mixture of kerosene and Lissapol N was tested against scale insects. It was found to be distinctly less effective than the emulsion made with soap, as long advised. In the same area, treatments that kept plants free for three weeks of the ants that attended the scale insects, failed to affect the scale infestation.

A proprietary material tested as a deer repellent was found to have no value for this purpose. The need for a deer repellent remains.

Legume covers in the Institute compound have been attacked by eelworms. While soil injection with D-D was effective against them, it would not be economic on a plantation scale. Tests have been started to find the susceptibility of the different legumes to eelworm attack.

In pollination studies, many of the twentyone species of insect caught within or entering flowers have been identified by the Commonwealth Institute of Entomology.

Cultures of *Rhizobium* that are effective on *Flemingia congesta* have been obtained, ready to be supplied for inoculating this bush cover. Tests of methods of pre-treating legume cover crop seed have been made in collaboration with the Botanical Division.

Twelve hundred tubes of *Rhizobium* culture were distributed on request for the inoculation of seed of common legume covers.

CHEMICAL DIVISION

Investigations arising from advisory enquiries have been concerned largely with latex. A study of anticoagulants has provided useful information for preserving field latex in good fluid state both during transport and on standing. Marked improvement in the quality of latex concentrates has resulted from further work on volatile fatty acid (V.F.A.) formation. Problems associated with skim rubber, viz. low rubber hydrocarbon and high copper content, have been satisfactorily overcome in new modified methods of preparation.

On the dry rubber side, interest has been shown by consumers in the U.K. in two new types of rubber, partially purified crepe prepared from latex concentrate and rubber with easy processing characteristics. The cost of preparing cyclised rubber has

been reduced and demonstrations and advice on the method of preparation have been given to many interested producers. Reports from the U. K. on rubber lignin master-batches have been promising.

The rate of production of Technically Classified Rubber in Malaya increased during the year, the total quantity exported being 26,450 tons. The rubber consisted mainly of estate RSS IX and RSS 1; T.C. rubber packed in godowns amounted to only 1,400 tons. Development of technical classification for lower grades has been slow, probably due to the extra handling and storage which increases costs. A few consignments of remilled rubber were shipped during the year, but progress has been even slower than that for lower grade sheet, for similar reasons.

Difficulties in classifying smallholders sheet packed in godowns lead to a modification in the classification scheme, which whilst permitting closer control of the classes and reducing misclassification, does not change the existing class limits.

In view of the increase in demand for technical classification, plans for equipping another testing laboratory have been put in hand; the new station is expected to be ready for service early in 1954.

A preliminary survey of the microflora of Malayan field latices was commenced at the end of 1952. Examination of latices from ten estates selected to cover a wide area showed heavy contamination with a wide range of bacteria, many types having been identified. Light ammoniation of the latices had a selective action inhibiting some and stimulating the growth of other species.

A study of the enzymes present in latex has demonstrated activity of the following types, dehydrogenase, polyphenol oxidase, peroxidase, and ascorbic acid oxidase. No evidence for catalase or cytochrome reductase activity has been found.

A new method has been developed for extracting and purifying phosphatides from hevea latex and chemical analysis has permitted their composition to be estimated. The presence of a choline liberating enzyme in latex has been demonstrated and some of the factors influencing the breakdown of phosphatides have been described.

In order to investigate the non-rubber constituents of latex, a means of separating serum from rubber particles was essential. For this purpose high speed centrifuging was adopted and has been found to separate fresh latex into four distinct fractions. This has greatly facilitated the investigations.

Experiments using a soap titration method to determine size of latex particles have led to the conclusion that the method is unreliable. No definite evidence for differences between latices from different clones has been found.

Factors affecting the formation of volatile acids in latex have been studied. Delay in ammoniation, storage with inadequate amounts of ammonia and contamination with the previous day's crop are practices to be avoided if V.F.A. is to be kept low. The rate of increase in mechanical stability during storage can be adversely affected if high V.F.A. has been allowed to develop.

Alternative means of determining V.F.A. have been investigated, with a view to obtaining results more quickly. The method now proposed cuts down the test time from two hours to half an hour.

Earlier attempts to produce dry rubber from fresh latex by a continuous method of coagulation revealed two difficulties, the first was weak coagulum, the second daily variations in the coagulating properties of field latex. Experiments to obtain further

information on the mechanism of latex coagulation have now led to the development of an apparatus to measure coagulum strength. Trials with the machine have shown the importance of age of latex upon coagulation behaviour.

Further investigation of the rubber hydrocarbon has revealed a new method for determining the micro-gel content of fresh rubber. The proportion of micro-gel differs in sheets from different estates, but appears not to be appreciably affected by preparational processes. The importance of taking into account micro-gel content in determining molecular weight has been emphasised.

In view of the increased interest shown particularly by American consumers in cleanliness of raw rubber, attention has been given to methods of assessing the dirt content in commercial samples. Using the method selected, wide differences in the dirt content of different R.M.A. types were found for Malayan produced rubber.

Attempts have also been made to increase the accuracy and efficiency of the strain test used in the technical classification of rubber. A more rapid test has now been devised, which permits evaluation in a matter of a few hours, as compared with two days by the standard method. A brief investigation of the hardness test as an alternative means of classification has led to the conclusion that it is not likely to be more suitable than the strain test now employed.

A number of special purpose rubbers have been investigated during the year. These include bleached crepe, purified crepe, hardened crepe, rubber with special processing properties, cyclised rubber, rubber-lignin masterbatches, and air-dried sheet.

The line-ahead creping battery was finally assembled during the year and trials carried out with the complete unit. The use of a scrap washer and building-up rolls showed no advantage over the conventional macterator. The relatively light finishing rolls employed were found to be inadequate to produce fine crepe and it was concluded that heavier rolls would be preferable.

An interesting trial at the Experiment Station factory investigated factors making for variability in sheet rubber production. It was clearly demonstrated that the most effective factor in producing rubber with uniform vulcanising characteristics was blending of the sheets before baling.

SMALLHOLDERS' ADVISORY SERVICE

At the end of the year field staff on normal duty comprised 32 Rubber Instructors, 1 Junior Rubber Instructor and 30 Rubber Demonstrators. To offset the loss of Rubber Instructors the appointment of 10 Junior Rubber Instructors, a new grade of staff, was approved and candidates were selected ready for training in early 1954. One Rubber Demonstrator was promoted Junior Rubber Instructor.

Funds were provided to build quarters for Rubber Instructors in certain stations and steps taken to obtain house sites in ten stations.

Both headquarters and field staff have assisted as required in the Replanting Scheme and in collection and distribution of clonal seed for smallholders in cooperation with the Department of Agriculture. Assistance was also provided for the Joint Working Party to which Mr J. W. L. Bevan was seconded.

Mr L. R. Davidson prepared a report on rubber production on Penang Island in connection with an enquiry into the working of the Rubber Excise (Penang) Ordinance 1949.

Report of the Director

Less attention was given to advisory work on the processing of rubber as the major effort was directed to replanting work. During the first four months of the year 1,825 tons of smallholders' rubber was sold as latex for concentration or central manufacture of sheet, and a cooperative society to purchase smallholders' latex in the Ulu Langat valley successfully established by the Cooperative Societies Department with technical advice from the Institute.

Records on replanting acreages were not kept by Rubber Instructors as it was considered that more accurate figures would be available from the R.I.(R.)B., with which organisation the Institute worked in close cooperation.

New planting reported by Rubber Instructors in all States totalled 6,339 acres, there being no new planting in Selangor, Malacca or Province Wellesley.

Assistance from Colonial Development and Welfare funds for provision of planting materials ceased in March but arrangements for distribution of supplies remained unaltered, finance being obtained by the Department of Agriculture from the R.I.(R.)B.

The Institute continued to assist in the examination of sources of clonal seed, the collection and distribution of clonal seed. A total of 8,393,760 clonal seed was collected and distributed to all States in accordance with requirements. All seed was planted in State nurseries and the central nursery at the RRI Experiment Station was not replanted but produced 261,385 stumps for distribution during the two planting seasons.

Budwood was available throughout the country in excess of requirements.

Rubber Instructors recorded 9,080 acres of smallholdings planted with clonal seed during the year and 2,946 acres budgrafted. These figures indicate that 80 per cent of holdings previously planted with ordinary seed were satisfactorily budgrafted.

Replanting demonstrations previously established were continued but no new demonstrations will be undertaken in view of the large increase in replanting expected under the Replanting Scheme.

The smallholding at Ulu Klang was maintained and yield and girth records taken as required.

A leaflet on the manuring of replanted rubber was published in English, Malay, Chinese and Tamil editions.

A Rubber Instructor took part in fortnightly broadcasts of an 'Agricultural Forum' and plays written by a Rubber Instructor continued to be broadcast until the end of the series of 35 plays was reached in June.

STATISTICS SECTION

The Statistician, Mr D. R. Westgarth, was on long leave from July onwards but the remaining staff of one graduate assistant (Mr D. K. Dutta Ray) and three computers were on duty throughout the year. Mr Fong Chu Chai, Assistant Statistician, was on study leave in the United Kingdom.

The Statistician participated in the Third International Biometric Conference held in Italy in September 1953.

The Section was fully employed in analysing experimental data supplied by the Divisions and in providing advice on the design of new experiments. About 140 statistical reports were submitted to the Divisions during 1953 in the following proportions:

Soils Division	54 per cent
Botanical Division	30 per cent
Chemical Division	14 per cent
Pathological Division	2 per cent

These figures do not represent time spent and it is estimated that more than half the computing time was occupied on Botanical problems.

Work for the Botanical Division centred mainly on analyses of trials of clonal seedlings, standard clones and clones of the RRIM '500' series. Plans were submitted for several new trials of clonal seedlings and clones including those of the RRIM '600' series. A study was also made of yield data from a trial of slaughter tapping systems involving yield stimulants and plans for further tapping experiments were devised. Lay outs for these tapping trials were of fairly orthodox pattern but the need to minimise the effect of different tappers and also to achieve a simple arrangement of tapping tasks of widely different systems poses novel problems in field design.

Statistical techniques were used in the study of the Botanical work on yield prediction; the variability of sieve tube measurements of the 1949 and 1950 hand-pollinated seedlings and of the preliminary test yields of RRIM '600' series clones in a large scale trial were examined. There is some promise of significant correlation between these preliminary test yields and the subsequent yields of the clones in normal tapping which, if fully realised, will provide a basis for earlier provisional selection of the higher yielding clones. A detailed study has been completed of the effectiveness of Morris-Mann test tapping yields from a field of clonal seedlings at the Experiment Station in predicting the relative performance of individual trees during twelve years of normal tapping.

The major part of the work of the Soils Division dealt with the analysis of yield and girth observations from the series of estate manuring trials. Fertiliser effects on seed production, mineral content of bark, and bark renewal were also assessed. Statistical techniques were also used in laboratory studies of the effect of Krilium on soil porosity and in experiments on the effect of magnesium, potash and phosphate fertilisers on various contents of hevea plants cultivated in pots.

The Chemical Division's work on the technical classification of rubber provided a number of statistical problems; these included the estimation of the proportion of bales misclassified by a test station subject to error bias, and the effect of various innovations in estate factory procedure on the inter-bale variation. Among chemical trials of particular statistical interest was an investigation of the effects of modifying ten different factors in the preparation of cyclised rubber; a complete factorial test of all combinations of the ten factors was impractical because this would have entailed over 1000 preparations, but the adoption of fractionally replicated design allowed the examination of all the main effects and some selected interactions in only 32 observations.

Most of the work of the Statistics Section is concerned with the Divisional research programmes and with problems initiated by the Divisions. Direct requests for statistical advice from outside sources are rarely received except from other research organisations. Eleven such requests were dealt with in 1953, but our assistance was limited to advice rather than computing labour and consequently only a negligible proportion of our time was devoted to external advisory work. This is in contrast to the previous year when it was estimated to occupy as much as fifteen per cent.

During 1953, only nine visits were made to estates by members of this section to assist in the design of new field trials.

Report of the Director

R.R.I. EXPERIMENT STATION SUNGEI BULOH

All members of the senior staff were on duty throughout the year; 3 members of the junior staff were on long leave for 3 months each at various periods during the year.

There was no shortage of labour and at the end of the year there were 436 on the check roll (271 dependents) and 41 on contract (tappers). The health of the labour force continued to be satisfactory.

Visitors to the Station numbered 271; two training courses for Rubber Industry (Replanting) Board subordinate staff were held for a total of 64 trainees, and other courses were held for students from the School of Agriculture and for agricultural students from Brunei.

Both generators of electricity were out of action together earlier in the year, and as power and lighting had to be taken from the emergency set, some inconvenience was caused.

Considerable renovation of buildings went on and new buildings were erected comprising an office, 6 sets of lines and a semi detached junior staff quarter. Pumps, boilers and factory plant were satisfactory; piping and a hot water circulation system were installed in the air drying crepe shed.

The total acreage of the Experiment Station amounted to 2156 acres at the end of December 1953 and included a further 40 acres of newly planted land which had originally been felled during the Japanese occupation, then abandoned and allowed to grow up in lalang, intermixed with 'belukar' and sporadic forest trees.

The full recorded acreage are:

	Acres
Mature areas — tapped	1,102.75
Immature areas — rested	11.00
Immature areas and nurseries	601.00
New clearing	40.00
Replanting	15.75
Smallholders' nursery	191.75
Building sites and roads	87.25
Reserve (including swamp land)	106.50
Total	2,156.00

Replanting was done in some 16 acres of old rubber.

Budgrafting in the field was done in 8 experimental areas covering about 250 acres but relatively little manuring of immature rubber was carried out. All immature areas were inspected monthly and treated for termite attack, and 75 per cent of the immature rubber was inspected at least once during the year for root disease incidence.

Control of natural covers in mature areas was achieved by half yearly slashing and in the immature areas slashing was done quarterly. About 200 acres of mature trees received fertilisers under a programme of biennial manuring.

In all experimental manuring areas girth measurements were taken and yield recording continued by the cup coagulation system, samples being collected and weighed monthly. Applications of fertiliser were made in 5 manurial trials, yield and bark.

stimulant trials continued and the various tapping experiments were maintained throughout the year. Tests of weedicides and herbicides were made onalang, Siam weed and other covers.

The total production of rubber was 938,000 lb from 1103 acres in tapping, giving an average yield of 850 lb per acre for the year which was about 100 lb lower than in 1952.

Details of the grades of rubber were:

	<i>Ib</i>
RSS 1	308,227
RSS 2	65,163
RSS 3	348
Clippings	9,642
Air dried sheet	272,505
Concentrate d.r.c.	6,330
Latex for rubber d.r.c.	17,405
Crepe (experimental)	8,832
Crepe (re-milling)	153,157
Unmanufactured scrap	29,790
Cup samples	63,407

The Smallholders' nurseries supplied 7315 yards of budwood to smallholders and at the end of the year approximately 500,000 yards of budwood of approved clones was available for distribution.

INFORMATION

Since the effort and expenditure of the R.R.I. is estimated to be roughly half each for research and advisory work, some general picture of the latter function might be expected in the annual Reports. Such a picture is not easy to paint within the formal style of a report. Whilst research can be described in terms of achievement against the background of the research plan, with its many subdivisions, the advisory function is more diffuse — it mirrors the research plan in subject matter, but is itself as much elusive art as science. We have to deal with irrational factors as well as with rational, and the scientific method and approach does not suffice for the former.

Now, at the end of the first five years' plan, we can look upon our research achievements as an established capital fund of knowledge which will grow, and as it grows will continue to be drawn upon for the benefit of the industry. It is becoming more and more important, in the face of competition from synthetics, to see that our applied science is translated as 'science applied'. This is the purpose of our advisory work, and the weakest link in the vital chain of application is not the provision of good advice, but its acceptance. It does not suffice to pump out a stream of information to the industry.

Publication is one facet of advisory work and Mr D. R. Rexworthy, who is in charge of the Publications Section and the library, also keeps a watching brief on the general aspects of the advisory function. Our early efforts to organise advisory work separately from research were not successful, but the situation has changed a great deal after

twenty years experience and needs close and constant attention. For estates over 100 acres — smaller concerns have the Smallholders' Advisory Service — individual advice is given direct from the research Division concerned and although the need for coordination of advisory work as a whole grows ever more apparent, it remains essential that nothing shall come between the research officer and the estate. The practice of reporting advisory work separately from research under each Divisional head is continued, as for last year's Report.

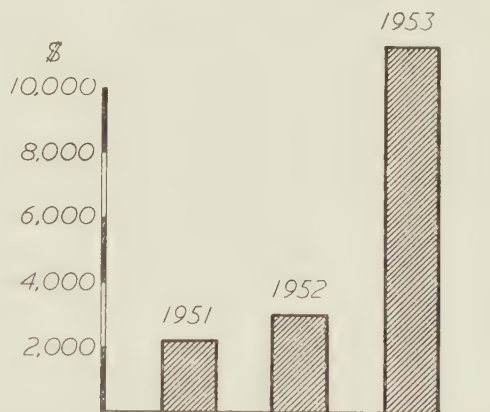
The new *Planters' Bulletin* has established itself successfully in its second year of publication, and does something to relieve research officers of the need to reiterate detailed general advice, verbally or in correspondence, but no form of publication can ever replace the most important element of successful advisory work—the personal link. At the end of the year the circulation of *Planters' Bulletin* was 2,532 gross, comprising 1,500 in Malaya, 389 to western countries and 343 to eastern countries. It is now widely abstracted and quoted. A special binder was made available for it at cost, and proved popular.

The *Journal of the Rubber Research Institute of Malaya* continued with eight Communications published in Volume 14; an effort was made to catch up the backlog of annual reports by completing Divisional issues for the years 1949-51 in such form that together they constitute an interim report on the five years' plan. A comprehensive price list of Publications of the R.R.I. was published, and numerous reprints were issued, including a collection in one cover of the series of *Studies in the Physiology of Latex* which appeared in *The New Phytologist*, and an article on *The Rubber Research Institute of Malaya from World Crops*, reprinted to serve as a brochure for our visitors.

The histogram gives some measure of the industry's interest in our publications — it shows actual sales over and above the wide free distribution. True and trite is the saying that people value most what they pay for. Pamphlets and circulars which arrive gratuitously through the post as 'printed matter' are apt to be pushed on one side, or worse, but a man will read what he has paid for in hard cash. As to the marked increase shown by the histogram over the past three years, this is to some extent due to closer attention to the purpose of our publications, especially in the light of our advisory service to planters.

Details of articles and communications, published by us or in outside journals, appear in the reports of the Divisions which follow. One interesting development arising from the need for uniformity in publishing was the preparation of a list of clone abbreviations* based on a few simple rules, which was submitted for international consideration.

A study of the needs for internal information was completed, as a result of which a pilot card index was planned, based on the Dawson system of classification which is accepted internationally. There are possibilities of extending this to advisory practice. The translation service was rationalised on a co-operative basis with the Rubber Research



* *Planters' Bulletin* 7, 85

Institute of Ceylon (who share costs) and other bodies, and a panel of specialised translators was built up. Forty translations were made during the year, bringing our total to 509. The work of the library continued steadily, and additions during the period of the five years' plan increased its holdings by 1800 volumes and 500 boxes of leaflets, etcetera.

Organisation of visits of parties to the R.R.I. and of the provision of R.R.I. lectures to local groups, devolved on the Publications and Information Section. The Section had no absences due to long leave.

C. E. T. MANN

Director

Soils Division

For the greater part of the year there were only two members of the senior staff on uninterrupted duty in the Division. Mr G. M. F. Grundy who throughout 1952 had been at the Imperial College of Tropical Agriculture, Trinidad, B.W.I. and at Rothamsted Experimental Station, England, for special study courses before taking up his new appointment at the Rubber Research Institute, arrived in Malaya in January 1953. Dr E. W. Bolle-Jones (Plant Physiologist), who was attached to the Botanical Division at the end of 1952, was transferred to the Division as from 1 January 1953, and continued to work on nutrition problems throughout the year.

Mr G. Owen (Soils Chemist) left for the United Kingdom on home leave in February 1953 and returned at the end of September to act as Head of Division. He was later appointed as Head of Division with effect from 1 December 1953.

The Head of Division (Mr C. G. Akhurst) was appointed Acting Deputy Director in March 1953 and later took over the duties of Director during the latter's absence on leave in the United Kingdom from April to October 1953. Mr Akhurst was appointed Deputy Director on 1 December 1953.

At the end of the year the staff of the Division consisted of 3 senior officers and 25 junior staff: Head of Division, Plant Physiologist, Soils Chemist, 1 Senior Laboratory Assistant, 12 Laboratory Assistants, 8 Field Assistants, 1 Typist and 3 Laboratory Attendants.

Contributions to the *Journal of the Rubber Research Institute of Malaya* were 'Determination of Available Nutrients in Malayan Soils' (Communication 282) and 'Studies on the Phosphate Problem in Malayan Soils' (Communication 283), both by G. Owen. The Plant Physiologist prepared a paper entitled 'Occurrence of Indole-3-Acetic Acid in Laminae of *Hevea brasiliensis*' for publication as a communication to *Nature*. Issues of *Planters' Bulletin* published in 1953 contained the following articles prepared by the Soils Division staff: 'Weed Control on Rubber Estates', 'Manuring Young Rubber Plants', 'Leaf Sampling for Diagnosis of Nutrient Deficiency', 'Soil Organic Matter and Krilium', 'Yield Maintenance of Mature Rubber Trees', and 'Fertiliser Treatment and Maintenance for Young Replantings'.

The usual assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by the preparation of examination questions and marking of papers in the soils section of the agricultural science examination.

Members of the Soils Division staff gave lectures at seven centres during the year to members of District Planters' Association or the Incorporated Society of Planters. As part of the training scheme for Replanting Assistants of the Rubber Industries (Replanting) Board, the Soils Chemist gave a course of six lectures on soils topics at the R.R.I. Experiment Station.

Building of the new extension to the Soils Division, and the new laboratories and glass house designed for extension of the work on nutrition of hevea, was started in April 1953 but the work was not completed by the end of the year.

Experimental work during 1953 has been confined mainly to problems relating to the nutrition of hevea. Owing to the preoccupation of the Head of Division with additional duties outside the Division (Acting Director and Acting Deputy Director) for the greater part of the year, and the absence of the Soils Chemist on long leave, there has been a temporary lull in soil investigational work apart from some explo-

ratory work on physical properties of soil carried out by Mr Grundy, and it was expedient to place all laboratory facilities at the disposal of the Plant Physiologist who devoted his time entirely to nutritional problems.

RESEARCH

SOIL SURVEY

Reference was made in the annual Report 1952 to observations made in eroded gulleys and other exposures on Singapore Island showing interesting features of rock weathering and soil erosion. Further observations were made early in 1953 and samples taken from different strata were analysed. It was concluded that high acidity and high sulphur content occur in relatively small pockets of dark coloured deposits widely distributed among the various strata, and there is no confirmation of the hypothesis that residual mangrove acid is the cause of the present rapid solution of silica and iron.

No other work under this section was done during the year. It has been decided that soil survey, involving classifying and mapping of soils is outside the scope of the work of the Institute and no further work directly concerned with soil survey problems will be done. Examination of soil profiles will continue but only insofar as this is necessary to appreciate and study other problems with which we are more directly concerned.

MANURING OF HEVEA

Effect of fertilisers on growth — Less time was devoted this year to growth studies in immature rubber areas. Data from four field experiments have been examined and the results confirm information which has been reported previously regarding the lack of response to fertiliser treatment in coastal alluvial soils. Of some interest is a comparison of the effects of soluble and insoluble phosphate on inland soils. In one experimental area, on a poor granite soil on Singapore Island, there was an indication that concentrated superphosphate was slightly more effective than rock phosphate although this conclusion is not accepted with confidence and requires confirmation from further measurements. But in another experimental area in Selangor it was confidently proven that soluble phosphate was not more effective than rock phosphate during the first year of growth. Mixing of the phosphate (soluble or insoluble) with the top six inches of soil in the planting hole was more effective than either surface application or placement in a band at two inches below the surface.

In regard to the effect of fertiliser applications on growth of mature trees data from eleven experiments have been examined but in only two of these has an effect due to treatment been demonstrated. In one area nitrogen was shown to have a beneficial effect and in the other, where symptoms of magnesium deficiency were apparent when the experiment was started, rate of growth as well as condition of the foliage were improved by applications of magnesium lime.

It is to be noted that the growth records examined cover the period two to three years after the commencement of the manuring programme.

Effect of fertilisers on yields—Yield records from 31 experiments were analysed during the year and again the results show that effects of manuring are not often noticeable in the first two or three years after commencement of a manuring programme. In 22

out of the 31 experiments there were no effects on yield due to fertiliser treatments. A beneficial effect due to applications of phosphate was established in 3 experiments and a response due to nitrogen in another. There were strong indications of a positive effect due to either nitrogen or phosphate in the remaining 5 experiments.

The only useful conclusion which can be drawn from the results at this stage is that in young mature rubber areas on inland soils, where the trees are perfectly normal judged from visual inspection, a measurable improvement in yield within the first two or three years after commencement of a manuring programme cannot often be expected as a result of fertiliser treatment. A few areas however do show a response even at this early stage. In our series of experiments the proportion of areas on inland soils which show no response, to those where a beneficial effect has been established in this early period during the first cycle of tapping is roughly 4:1. The effect of early manuring on yields later, when renewed bark is tapped remains to be seen. It is of interest to note that in all experiments where a response to fertiliser treatment has been established with confidence, or is indicated as a probability, the effect is due either to nitrogen or phosphate. No firm evidence of any yield response due to treatment with potash has been detected so far.

It is generally accepted that applications of nitrogenous fertilisers are needed in mature rubber areas on inland soils but the experimental evidence indicates quite clearly that applications of phosphate also can be expected to have a beneficial effect on yields during the early years of maturity. A safe recommendation for young mature rubber on most inland soils is therefore the application of nitrogen and phosphorus, either as a mixture, or separately in alternate applications. In some areas a complete fertiliser may be necessary and sometimes the addition of magnesium may be beneficial, but these are exceptional cases and will normally be recognised on inspection.

It is emphasised that the results available now are by no means conclusive. Manuring must be regarded as a long term project and it will take many years to determine its full effect on rubber trees.

Effect of fertilisers on seed production—Freshly fallen seeds in the different plots of one manuring experiment were counted on two occasions. Results obtained from the two sets of records were similar. There is evidence that treatment with both nitrogen and phosphate was effective in increasing seed production in this area while there is no indication of an effect due to potash.

The effect due to nitrogen is non-linear and it is probable that the optimum effect was reached at the second level (4.5 lb per tree per application). The effect due to phosphate is highly significant and is predominantly linear.

Other effects of fertilisers—Yield differences between clones in the manuring experiments are highly significant. Clones Tjir 1 and PB 86 are usually the highest yielders although their positions relative to one another on the scale are not always consistent. However there is no indication so far of a clone x treatment interaction. Where a response to fertiliser applications has been established in areas which carry two or more clones, all clones show similar effects.

Measurements of the thickness of virgin and renewed bark were recorded in a manuring experiment at the R.R.I. Experiment Station. Both sets of measurements showed marked differences between clones (clones Pil B84 and Tjir 1 had the thickest bark and BD 5 the thinnest), but there were no significant differences in bark thickness due to fertiliser treatments even though treatment effects on yield in this experiment were significant.

The incidence of brown bast was studied in four manuring experiments. The number of affected trees was relatively high (over 10 per cent) in only one experiment,

a clonal seedling area. Census figures for this experiment were analysed but no effect on incidence of brown bast due to fertiliser treatment was established with confidence.

CULTIVATION AND COVER CROPS

The results of an experiment carried out to determine the effect of solutions of twelve different types of herbicides used as pre-emergent sprays showed that pre-emergent spraying could not be considered a satisfactory and economic method of controlling weeds in rubber nurseries. Regeneration of weeds occurred to a varying degree depending on the solution used but most plots had to be weeded in the normal way about a month after spraying. Ammonium sulfamate, maleic hydrazide and the sodium salt of 2,4-D were comparatively ineffective. The emergence of broad leaf weeds was controlled best by sodium pentachlorophenate, 3-(p-chlorophenyl)-1, 1-dimethylurea (C.M.U.), iso-Propylphenylcarbamate, ethyl ester of 2,4-D, acid butyl ester of 2,4,5-T and the combination of sodium trichloroacetate with the sodium salt of 2,4-D. Emergence of grasses was most effectively controlled by sodium trichloroacetate, C.M.U., 2,4-D dimethylamine salt, acid butyl ester of 2,4,5-T and the combination of sodium T.C.A. with sodium salt of 2,4-D. Taking into consideration the effect on all types of growth, and the rate of regeneration after treatment, the most successful control of weeds was obtained with C.M.U., but because of its persistence in the soil this caused heavy casualties among the rubber seedlings planted after spraying.

Experiments on control ofalang (*Imperata cylindrica*) were continued. Comparisons were made between proprietary weed killers (Brenco and Kanex), sodium arsenite, sodium trichloroacetate and oil-water emulsions fortified with sodium T.C.A., sodium pentachlorophenate and ammonium sulfamate. Brenco (arsenic pentoxide) was no more effective than sodium arsenite. Spraying with sodium trichloroacetate was the most effective treatment.

Several reports were received concerning defoliation of young rubber trees caused by sodium trichloroacetate used for eradicating weeds in rubber areas. A spraying trial with sodium T.C.A. over a range of concentrations was carried out in an area where buddings of clone Tjir 1 are growing. Spraying was done in August 1953 and observations made up to the end of the year are reported. The severity of the damage caused to the young rubber trees increased with increasing rates of application of the sodium T.C.A. At the rate of 50 lb per acre just under 20 per cent of the trees suffered partial or complete defoliation. There was some dieback of the upper branches but all affected trees were re-foliating at the end of the year. At 100 lb per acre about 60 per cent of the trees showed symptoms of a harmful effect; there was considerable rim scorching and discoloration of the laminae followed by partial or complete defoliation. New foliage developed later and all the trees are recovering. In the plots treated at the rate of 150 lb per acre the effect was similar but more severe; a few of the trees had showed no signs of re-foliating at the end of the year. Almost complete defoliation of more than 80 per cent of the trees occurred when the sodium T.C.A. was applied at the rate of 200 lb per acre. New foliage which developed subsequently dropped off later, and few of the affected trees were showing signs of recovery at five months after treatment. There was considerable dieback of branches and development of new shoots at the end of the year was confined to the lower parts of the trees.

A similar spraying trial with Ammate was carried out later using the same range of application rates as in the experiment with sodium T.C.A. No harmful effect on the rubber plants was noticeable.

In the plots where attempts are being made to control alalang by the shade of planted tree species further observations were recorded in collaboration with officers of the Forest Research Institute. The growth of alalang was weakening noticeably, but its suppression is due partly to direct shade of the planted trees and partly to natural

colonisation by other plant species which does occur provided the lalang escapes being burnt in the meantime. An accidental fire occurred over a part of the area towards the end of the year. All the *Casuarina* trees were killed. A few *Albizzia* trees whose bark on part of the butt was killed by the fire showed signs of recovery. The tree species which survived best were *Styrax benzoin*, *Pagraea fragrans* (Tembusu) and *Anacardium occidentale* (Cashew nut). Lalang was regenerating vigorously in the section where the burn occurred.

MECHANICAL CULTIVATION

There are no observations of interest to report under this heading. Cultivation treatments (ploughing and harrowing) with and without manuring were carried out for the fourth year in succession in our experimental area where the trees are mature. No effect on growth or yield of the trees has been detected.

LABORATORY INVESTIGATIONS

Most of the laboratory work carried out during the year relates to studies on nutrition of rubber plants based on observations and analysis of plants grown in pots.

Methods and techniques for the study of the nutrition of hevea — Methods of estimating the nutrient elements in soil and plant tissue are constantly being examined and tested with a view to improvement in accuracy and speed of routine analytical work. Chemical methods for estimating potassium, iron, manganese, zinc and boron in plant tissues were examined during the year and satisfactory procedures were developed.

Repeated attempts to determine molybdenum in solutions by the use of *Aspergillus niger* as a bioassay organism have not been completely successful despite purification of the nutrient salts by successive re-crystallization. Blank values were high and it was suspected that in addition to salt contamination, the mode of sub-culturing the fungus on a 'complete agar' medium provided the spores with sufficient molybdenum for the fungus' requirement. The fungus is now being sub-cultured on successive molybdenum deficient media in order to reduce the molybdenum content of the inoculum. The bioassay method as now operated can be used for relatively crude estimations but lacks the sensitivity necessary for estimating minute traces of molybdenum.

The difficulties experienced with the colorimetric method of estimating sugars in leaf tissues were overcome by using a simple paper chromatographic technique which has been developed and found successful. This procedure was used for the estimation of sugars in laminae borne on plants of different mineral status. Glucose, fructose, sucrose and inositol (both meso- and laevo-) were always present. The amount of sucrose present was greatly in excess of either inositol, glucose or fructose. Amounts of glucose and fructose were similar and these were present in much greater quantities than inositol.

A method of estimating chlorophyll in the lamina of hevea was investigated. Percentage transmittance data were received for extracts of rubber leaves which had been sent to the National Physical Laboratory for spectrophotometric measurement. Using these data a standard calibration curve was prepared from which concentrations of chlorophyll in leaf extracts were determined.

Auxins in the laminae of hevea have been detected by paper chromatographic methods and the presence of indole-3-acetic acid was confirmed by positive growth stimulation of coleoptile sections of oats.

Standard methods of estimating the concentration of rubber hydrocarbon in plant tissues are laborious and time consuming. It was necessary to consider the possibility

of developing a simpler and quicker method for routine examination of a large number of samples. A new rapid method suitable for approximate estimation of rubber hydrocarbon in a large number of petiole samples has been evolved and put into use.*

Diurnal variation in the mineral constituents of the laminae of hevea—Variations in the contents of mineral constituents of leaf samples taken at two hourly intervals from 0600 hrs to 2200 hrs on three separate days were studied. The results showed that for N, P, K, Ca and Mn contents there was no evidence of significant variability associated with the time of day.

The magnesium content showed a significant diurnal variation; the values fell markedly after midday and increased again towards evening. The absence of a significant 'days x times' interaction demonstrated that the diurnal change in Mg content was similar on all three sampling days.

Diurnal changes were also shown to occur in iron content but the variation was not consistent on each of the three days. On the first day there was a general decrease in iron content as the day progressed, with the most marked change occurring between noon and 1400 hours. On the second day changes were less pronounced and the lower values were observed at noon and 1400 hours. On the third day changes were not significant.

Judging from these results it would seem that the best time for leaf sampling is between 0800 and 1000 hours when the mineral contents show least variation.

Interclonal differences and seasonal variation in the chemical composition of the lamina of hevea — Leaf samples of three different clones (Tjir 1, RRIM 501 and PB 86) taken at approximately monthly intervals since May 1953 have been analysed. Rubber concentration in the petioles and chlorophyll concentration in the laminae were always highest in Tjir 1 and least in PB 86. Both the ash and calcium contents of the laminae of Tjir 1 and PB 86 were similar while those of RRIM 501 were usually appreciably less. Nitrogen contents were consistently higher in leaves of Tjir 1 and RRIM 501 than in those of PB 86. Values for potassium were lowest in RRIM 501. The relative magnitude of the magnesium value in the three different clones was not consistent but during the later months of the year the magnesium content was least in RRIM 501. No distinct clonal differences were apparent in respect to phosphorus, iron and manganese contents..

The contents of rubber (in the petiole), chlorophyll and all minerals except P and K were subject to considerable seasonal fluctuation.

The study of nutrient status of yellow leaved clones and seedlings—The mineral composition of leaves taken from 'genetic yellow' buddings, the 'yellow' mother seedling trees from which they were derived, and that of normal or 'green' buddings growing adjacent to the 'genetic yellow' variety were determined and the results examined. It was concluded from these results that the foliage of 'genetic yellow' clones and the 'yellow' mother seedling trees differed chiefly from the normal or 'green' clones in the existence of positive covariations between chlorophyll and calcium contents or Ca/K ratio in the top whorl laminae. Increased chlorophyll production seems to be related to a reduction in the proportion of potassium in relation to the calcium content of the leaves.

This study, however, was of a preliminary nature and the conclusions drawn require confirmation.

Bark sampling for purposes of assessing nutrient status of trees — It is generally accepted that the nutrient status of a plant is reflected most satisfactorily by the

*(Note: The work on experimental methods which has been mentioned above is described in more detail in Communication 289 of the J. Rubb. Res. Inst. Malaya, 14 (1954) 183).

chemical composition of the leaf tissues; leaf analysis is commonly carried out for purposes of diagnosing nutrient disorders in the plant. But when dealing with tree crops, sampling of leaves for diagnostic purposes present a difficult problem because of variations in the chemical composition according to age of leaves, diurnal and seasonal fluctuations and, above all, the practical difficulty of getting a large number of representative samples from tall mature trees. The possibility of assessing nutrient status of trees by analysing bark samples was considered. Preliminary work showed that height of sampling was not an important factor. Sections of bark were then taken at a pre-determined level from trees in the plots of a fertiliser field experiment and the contents of major nutrient elements were estimated. Examination of the results failed to establish any significant differences due to fertiliser treatments. The results suggest that bark analysis may not be a satisfactory alternative for leaf analysis as a means of assessing the nutrient status of trees.

POT CULTURE EXPERIMENTS

Continued modification of the composition of the nutrient solution in the light of observations made on the growth of the rubber plants has resulted in the use of nutrient solution which contained (in m.eq. per litre):

$\text{NO}_3^- = 7.0$, $\text{PO}_4^{---} = 3.0$, $\text{Mg}^{++} = 2.0$, $\text{K}^+ = 4.0$, $\text{Ca}^{++} = 4.0$, $\text{SO}_4^{--} = 3.0$ – 4.0 , $\text{Fe}^{+++} = 1.0$, $\text{Mn}^{++} = 0.02$, $\text{Cu}^{++} = 0.002$, $\text{Zn}^{++} = 0.002$ and $\text{Mo} = 0.0002$ millimols.

The high boron content of the complete nutrient plants and the healthy dark green condition of the boron deficient plants indicated that boron toxicity might become operative if the plants were continued to be fed with boron. Consequently boron was omitted from the micro-nutrients from August onwards. Some improvement in appearance resulted.

Experiment I. The interrelationship of Mg, K and P — Treatments included three levels of each nutrient in a $3 \times 3 \times 3$ factorial layout. The three nutrient levels were estimated to cover the range from deficiency to luxury feeding levels. The experiment was started on 6 March and terminated on 5 October 1953. The observations and results will be discussed in more detail in a paper to be published in the *Journal of the R.R.I. of Malaya* but in the meantime the following brief notes may be of interest.

In regard to height measurements the tallest plants in the experiment grew in the $\text{Mg}_1\text{K}_2\text{P}_2$ and the smallest in the $\text{Mg}_3\text{K}_2\text{P}_2$ treatments. Increased addition of Mg had a general depressive effect on height except at the higher K levels. Increasing K supply also depressed height elongation especially at the low Mg level.

An increase in the number of leaflets per plant was produced by increased Mg supply; this effect was most marked in the P_3 treatment. Additional K decreased the number of leaflets especially at the low Mg level while additional P had the opposite effect particularly at the K_1 level.

Symptoms of magnesium deficiency were mainly confined to the lower Mg levels with the higher K and P treatments. Symptoms of potassium deficiency first appeared in the high Mg low K treatments but later became apparent at all levels of Mg. The symptoms developed as a yellowish mottling of the lamina followed by a tip and marginal scorch. The scorching effects were mainly confined to the low K high P treatments at all Mg levels. Phosphorus deficiency was manifested as a purplish tinting of the younger laminae followed, in the more severe cases, by a necrosis of the leaf tip which turned upwards, becoming twisted. Symptoms appeared first in the P_1 treatment with a tendency to be more prominent at lowest Mg level.

The total dry weight of the plants was decreased by increasing the supplies of potassium and of magnesium, while the higher levels of phosphorus had a beneficial effect.

In regard to concentration of rubber hydrocarbon in the stems and petioles of the plants this was decreased during the early stages of growth (April-May sampling) by increasing the levels of Mg. No consistent effect of Mg level was apparent later, in June and July, but a slight increase was obtained in October (at 7 months after planting). Increasing the supply of K generally produced an increase in rubber concentration and increasing the P level also had a beneficial effect.

The chlorophyll content of the laminae was increased by increasing levels of Mg and of K. Increased levels of P caused a reduction in chlorophyll content at the earlier sampling but in later samplings this effect diminished.

Examination of the relative concentrations of Mg, K and P in the leaves showed the following interaction effects — Mg x K, Mg x P, K x P. These interaction effects, however, were not always consistent, sometimes changing with increasing age of the plants. At the earlier samplings, for instance, increased magnesium supply caused a significant reduction in the phosphorus content of the first and second whorl laminae but later this effect was reversed. The effect of increased K level on P content was also not consistent.

When correlating visual observations with the results of analysis of the leaves it was found that K/Mg ratio values were high where magnesium deficiency symptoms were clearly apparent. In general, these ratio values seemed to furnish a better guide than the magnesium content to the occurrence of magnesium deficiency symptoms.

Experiment II. Survey of nutrient deficiency symptoms—The purpose of this experiment was to study the effect on the plants of withholding each of nine nutrient elements from the nutrient solutions supplied to the plants. The treatments included: complete, -N, -P, -K, -Mg, -Ca, -S, -Fe, -Mn, -B, but after a short period of growth it was found necessary, owing to the severity of the symptoms produced, to include low levels of nitrate, sulphate and magnesium in the -N, -S and -Mg treatment respectively to avoid death of the plants.

The complete nutrient plants were vigorous and were the tallest plants at the end of the year. Height elongation was noticeably reduced at an early stage due to deficiencies of N, S, Mg and Ca while a similar effect due to lack of P became apparent later. Growth retardation due to deficiency levels of Fe and Mn was appreciably less and the B deficient plants were only slightly shorter than the complete nutrient plants.

The number of leaflets per plant was reduced by deficiencies of N, S, P, K, Mg, Fe and Mn whereas B deficiency had no apparent effect.

Detailed observations on the visual symptoms of deficiency of each nutrient element have been recorded and will be described in a report to be published in the *Journal of the R.R.I. of Malaya*. Deficiencies of each element except calcium resulted in the development of fairly well defined abnormalities which, having been recognised, will be useful for diagnostic purposes.

The chlorophyll content of the laminae was depleted by deficiencies of K, Mg and Fe. The laminae of the boron deficient plant, on the other hand, contained more chlorophyll than those of the complete nutrient plants, which fact was consistent with their dark green appearance.

The concentration of rubber in the stems and petioles was determined at intervals during the course of the experiment. Judging from the results obtained it would seem that differences in the mineral status of plants will have a direct effect on rubber concentration only in the earlier stages of growth when growth differences due to treatment are relatively small. Later on, when growth differences due to treatment were larger the total rubber content was more closely correlated with the total dry weight of the plant

rather than with mineral status and there was no strong indication that deficiency of any one of the nutrient elements tested had any effect on the rubber concentration in the stems and petioles. Under field conditions it can be expected that where nutrient deficiencies are sufficiently acute to cause a decrease in vigour and growth of the plant the yield of rubber per tree will be reduced.

SOIL INVESTIGATIONS

Some preliminary tests with Kriliun were carried out. The results showed that addition of 0.05 per cent and 0.10 per cent Kriliun produced measurably increased permeability to water in heavier soils containing more than 30 per cent clay but there was no effect on the lighter soils. Application of Kriliun in the planting hole in a coastal area, where the soil is a heavy alluvial clay, had no measurable effect on growth of young rubber plants in the first five months after planting.

Exploratory work has been in progress to study methods for assessing the physical properties of soils. Determinations carried out were percentage air by volume, percentage water by volume, percolation rate and percentage pore space. The work is still in the exploratory stage but results to date do not reflect sufficiently clearly and consistently the differences between good and bad physical conditions of soils in rubber areas. Work on this project is continuing.

ADVISORY

The number of requests for advice was greater in 1953 than in the previous year. Data relating to advisory work and correspondence are:

Letters despatched:	478
Visits to estates:	95
Interviews at the Institute:	162

Enquiries covered a wide field but, as in previous years, the principal subjects dealt with in advisory correspondence were manuring problems and weed eradication, accounting for 60 per cent of the advisory letters despatched.

Manuring

Little interest was shown in manuring of old unselected seedling trees as it is now generally accepted that heavy expenditure on fertiliser applications in such areas would probably not be completely recovered in the form of increased crop. On the majority of estates these low yielding older areas are earmarked for replanting as part of the programme for progressive development for it is recognised that only by replanting with modern high yielding material can such areas be converted into competitive economic units.

Although factual information on the effect of manuring young mature areas is still extremely limited it is a common practice to initiate a manuring programme soon after commencement of tapping mainly with a view to maintaining yields and avoiding the necessity for reducing the intensity of tapping for as long as possible. Advice has been sought regarding suitable manuring programmes.

In regard to young immature areas manuring at regular intervals from time of planting to maturity is accepted as normal routine. Enquiries have been concerned mainly

with types of fertilisers to use and methods of application. Several requests were received, as usual, to diagnose the cause of backward growth in immature areas.

Weed Control

Various species of grasses are the most troublesome weeds on rubber estates and eradication of these has been the main subject of enquiry. Spraying with a dilute solution of sodium arsenite continues to be the most favoured method of eradicating dense growth ofalang as this treatment is appreciably cheaper than the alternative treatments which have proved effective such as spraying with oils or fortified oil emulsions. Spraying with a solution of sodium trichloracetate appeared at first to be a promising alternative as only one spraying is required compared with several rounds of spraying when using sodium arsenite. But several reports were received of severe defoliation of young rubber trees in areas sprayed with sodium trichloracetate and the use of this weed killer in rubber areas has practically ceased. Sodium trichloracetate is one of the few weed killers that is active in the soil and is absorbed by the roots of plants. Persistence of herbicidal activity in the soil is a strong disadvantage when the purpose is to eradicate weeds in rubber areas.

For elimination of sporadic growth ofalang wiping with oil is now a method which is used extensively in rubber areas. Tufts of the long grass are squeezed at the base with an oily rag and the blades are then wiped by drawing the rag upwards. This apparently laborious procedure is simple in practice and it is actually cheaper and more effective than spraying when dealing with sporadic growth ofalang. In areas where the growth ofalang is dense the procedure commonly followed is to spray three or four times with a solution of sodium arsenite and then eradicating new growth by wiping with oil.

Small scale trials were carried out to compare the effect of soils containing a high proportion of aromatic fractions (Sovacide PY and PYD, Shell Lallang Oil) with that of the cheaper diesel fuel oil. The results confirm that the latter is slower in action but the final effect was the same whichever oil was used for the wiping procedure. However, it would appear that the oils containing the higher aromatic components are still favoured on most estates because the effect of wiping becomes apparent more quickly.

Towards the end of the year there was an increase in the number of enquiries concerning methods of eradicating specific plant species including grasses, ferns and other types of indigenous growths. *Ischaemum muticum* is a grass which is very difficult to eradicate and was the subject of several enquiries. None of the known herbicides which can safely be used in rubber areas is completely effective and no satisfactory method can be recommended other than hand weeding or removal by mechanical cultivation. The trend of enquiries indicated the need for obtaining specific information on the effect of different herbicides on a variety of plant species commonly found on rubber estates and consequently the experimental work on weed control is being extended to include most indigenous growths.

C. G. AKHURST
Head of Soils Division

Botanical Division

Dr E. D. C. Baptist (Head of Division), Mr H. M. Burkill (Botanist), Mr T. V. Vaidyanathan (Assistant Botanist) and Mr V. K. Bhaskaran Nair (Assistant Botanist) were on duty throughout the year. Mr C. W. Brookson (Botanist) went on long leave on 28 July and Mr P. de Jonge (Botanist) on 19 December.

Two new appointments were made during the year Dr J. S. Lowe assumed duty on 11 February as plant physiologist for fundamental research on the physiology of latex formation. Dr P. K. Wycherley assumed duty on 26 January as plant taxonomist, for a special study of the taxonomy of *hevea*, first in Malaya and later, possibly, on secondment to America to work in close liaison with the Officers of the Rubber Plants Investigations Division of the U.S. Department of Agriculture attached to the Latin American Cooperative plan for investigations in rubber production.

These two new members of the Senior Staff of the Division took up residence on the R.R.I. Experiment Station during March and worked in the new laboratory for latex research which has been erected on the Experiment Station.

The staff of the Division during the year under review consisted of 6 senior officers, 2 graduate assistants, 11 laboratory assistants, 13 field assistants and 2 laboratory attendants.

Of the Junior staff at headquarters 4 assistants are available for field work i.e. for inspecting the experimental areas and 2 assistants perform the duties of Division clerks i.e. typing outgoing letters and reports and filing correspondence. The other 8 assistants are almost entirely engaged on ledger recording work.

Nine of the field assistants, and one laboratory assistant, are domiciled on the R.R.I. Experiment Station where the work consists mainly of individual tree yield recording in field trials, establishment and maintenance of field trials, routine growth measurements, preparation and care of nurseries and supplying budwood ordered by estates.

An article entitled 'Improvement of Yields in *Hevea Brasiliensis*' by the Head of Division was published in *World Crops* 5 (1953) 194.

A paper entitled 'Recent Progress in Malaya in the Breeding and Selection of Clones of *Hevea Brasiliensis*' prepared by the Head of Division and Mr C. W. Brookson and read by the former to the Thirteenth International Horticultural Congress held in London during September 1952 was published in full in the report of the Congress published in 1953.

The following papers by members of the Botanical Division read at the Conference of Rubber Research Institutes in the Far East held in Bogor in July 1952 were published in May 1953 in a special number of *Archief voor de Rubbercultuur*: 'Performance of Clones and Clonal Seedling Families in Large Scale Experiments on Estates' by H. M. Burkill; 'The Breeding and Selection of *Hevea Brasiliensis*' by C. W. Brookson; 'Stimulation of Yield in *Hevea Brasiliensis*' by P. de Jonge.

The following articles prepared by members of the Division were published in *Planters' Bulletin* during 1953: 'Seed Gardens for Estates', 'Hand Pollination in *Hevea Brasiliensis*', 'A New Legume Bush Cover Plant: *Flemingia Congesta*', 'Prang Besar 86 as a Seed Parent', 'Stump Planting', 'R.R.I. '600' Series', 'Stimulation of Yield of Rubber Trees', Editorials: 'History of Tapping', and 'Tapping: An Introduction'.

The last two sections 'Use as a Yield Stimulant' and 'Use as a Tree Poison' of article 'Uses of 2, 4, 5-T on *Hevea*—Preliminary Note' were published in the *Journal of the Rubber Research Institute of Malaya* as Communication 288.

Lectures given by members of the staff during the year were as follows:

'Present Trends in the Use of Planting Material' on 22 February to the Malacca Planters' Association; 'Problems of Current Interest on Estates' on 14 April to the Bahau/Kuala Pilah Branch of the Incorporated Society of Planters; 'Stimulation of Yield in Hevea' on 10 May to Ulu Selangor District Planters' Association; 'Plant Breeding and Testing' on 12 May to the Bahau/Kuala Pilah District Planters' Association; 'Plant Breeding and Testing' on 23 May to the Johore Planters' Association (West Section); 'Yield Improvement in Hevea — Present Trends in the Choice of Planting Material' on 21 June to the Central Selangor Branch of the Incorporated Society of Planters; 'Slaughter Tapping' on 10 July to the Trainees of the Rubber Industry (Replanting) Board; 'Yield Improvements in Hevea' on 11 July to the Staff of Jugra Land & Carey Ltd, Carey Island; 'Tapping and Tapping Systems' on 16 July to the Trainees of Rubber Industry (Replanting) Board; 'Planting Distances and Planting Density' on 20 July to Trainees of Rubber Industry (Replanting) Board; 'Problems of Current Interest on Estates' on 27 August (morning) to Kedah South and Province Wellesley Branch of Incorporated Society of Planters; 'Improvement of Yields in Hevea' on 27 August (evening) to the Kedah North and Central Branch of Incorporated Society of Planters; 'Clones and Clonal Seedlings' on 4 May to the Central Perak Branch of the Incorporated Society of Planters; 'Clones and Clonal Seedlings' on 11 July to the South Johore Branch of the Incorporated Society of Planters; 'Budgrafting' on 20 July to the Trainees of Rubber Industry (Replanting) Board; 'Clones and Clonal Seedlings' on 24 August to the Johore Planters Association (West Section); 'Planting Material' on 28 August to the Trainees of Rubber Industry (Replanting) Board.

In connection with experimental planting on estates research officers visited 36 estates and field assistants spent altogether 378 days working on experimental areas on estates.

Research Officers paid 251 visits to the R.R.I. Experiment Station and field assistants from headquarters worked at the Experiment Station on 36 days.

RESEARCH

BREEDING AND SELECTION

Hand Pollination

Approximately seventeen thousand hand pollinations, an increase of about two and half times on previous years, were carried out during the main flowering season of the year.

At the end of the second quarter 610 fruits had set but of these only 376 were harvested, giving a final success of 2.2 per cent in fruit. Storm and squirrel damage accounted for the heavy losses.

The object of the programme was to cross the good seed parents used in the 1937 hand pollinations, namely Tjir 1, PB 49 and AVROS 157, with clones found to be good parents in Indonesia and Indochina, namely Djas 1, Waring 1 and 4 and PR 107, and with RRIM clones 513 and 527. Clone PR 107 was also crossed with RRIM clones 603 and 616.

Two crosses namely RRIM 527 x AVROS 157 (1119 pollinations) and RRIM 513 x Tjir 1 (1079 pollinations) did not set fruit and the failure may be due to genetic incompatibility between these clones.

It is noted in this connection that in the 1952 pollinations the cross RRIM 527 x PB 49 (430 pollinations) did not produce any fruit. The percentage of pollination successes varied from 0 for the two crosses described above to 4.4 for the cross PR 107 x RRIM 616.

The percentage of seed germination ranged from 5.6 for the cross PR 107 x AVROS 157 to 97.6 for the cross Waring 4 x Tjir 1, with an average of 66.5 for all crosses.

Seedling Families

The first supply of high grade seed for use in the replanting of smallholdings should be available during the main seedling season of 1954 from the seed gardens of approximately 190 acres established on the R.R.I. Experiment Station under the Colonial Development and Welfare Scheme D 1176, as flowering was observed on all clones and fruit on some clones, notably AVROS 157, BR 2 and Tjir 1, during 1953. The planting is on the hedge system sixty feet between the rows and four and a half feet along the row.

Budding took place in 1950/51 and five clones, selected from clones RRIM 501, 509, 526, PR 107, AVROS 157, PB 49, TK 14 and BR 2, are represented in each garden with clone Tjir 1 common to all gardens.

The elimination in late 1953 of a mixed planting of *Hevea brasiliensis* with *Hevea spruceana* will allow usable seed to be collected from neighbouring seed garden A.

Two hundred and fiftytwo seedlings of the 1951 hand pollination programme were planted out as stumps during the last quarter 1953 in Field 16 North, the first field on the R.R.I. Experiment Station to be replanted. The balance of the area was planted with 459 illegitimate seedlings from eight RRIM '600' series clones and 42 illegitimate seedlings of clone Tjir 1.

Measurements of bark thickness and counts of latex vessel rows were carried out on bark samples taken at a height of 20 inches from the ground on 438 two year old seedlings of the R.R.I. 1951 Collection. It was found that while *Hevea brasiliensis* seedlings from both Peru and Brazil displayed similar characters in this respect, *Hevea benthamiana* was markedly inferior to both in bark thickness and the mean number of latex vessel rows.

In the trial of the 1937 hand pollinated seedlings, families Pil B84 x AVROS 157, Tjir 1 x PB 24 and AVROS 157 x PB 49 gave the highest yields per tree per year, these being 32 lb, 27.9 lb, and 26.3 lb, respectively against the yield of the budded control clone Pil B84, of 14 lb. The two highest yielding families had a brown bast incidence of 32 per cent and 54 per cent respectively, against the low figure of 10 per cent for the AVROS 157 x PB 49 family.

In the trial of the 1938 hand pollinated seedlings the two outstanding families were RRIM 509 x Tjir 1, with a yield of 27.3 lb per tree per annum and brown bast incidence of 20 per cent, and RRIM 500 x Tjir I which gave 25.8 lb per tree per annum with a brown bast incidence of 80 per cent. The budded control of clone Pil B84 gave 13.2 lb.

Families Tjir 1 x Pil B84 and Lun N x Tjir 1 were the highest yielding families in the trial of the 1939 hand pollinated seedlings, with yields of 26.6 and 24.4 lb per tree per year, both showing a considerable increase over the previous year. The incidence of brown bast was 51 per cent and 60 per cent respectively. The yield of the budded control clone Pil B84 was 14.4 lb per tree per annum.

Families Tjir 1 x RRIM 528 and Pil B84 x RRIM 501 yielded 23.8 and 23.6 lb per tree per annum in the trial of the 1940 hand pollinated seedlings, the former with a

brown bast incidence of 22 per cent and the latter with an incidence of 10 per cent, this latter figure being accounted for by the fact that only one tree of the family exists.

In the trial of the 1941 hand pollinated seedlings the families Tjir 1 x RRIM 509, Tjir 1 x RRIM 500 and Tjir 1 x Lun N gave yields of 21.3, 20.9 and 20.1 lb per tree per annum.

In the old trial of seedlings from Isolated seed gardens AVROS 157 and PB 25 from Batu Kawan I.S.G. gave the highest yielding families yielding 18.1 and 19.5 lb per tree per annum, with a mean over seven years of 19.6 and 19.3 lb per tree, and the low incidence of 18 per cent and 12 per cent brown bast respectively.

Clones

Three hundred and fortyone seedlings grown from seed imported from Tropical America in May 1951 and known as R.R.I. 1951 Collection have been made into clones and budded in April 1953, along with clones RRIM 501 and 513, in a clone trial of a cubic lattice design ($7^3 = 343$), with three replications of each clone, in Field 55, R.R.I. Experiment Station.

Of the remaining seedlings of this collection 114 were selected for vigour and the clones made from these were established in a small scale trial with twelve planting points to each clone. Thirtythree clones made from seedlings of a cross of *Hevea spruceana* with clone Tjir 1 were budded in the same trial.

Two hundred and seventyfive seedlings of a second importation made in 1952 and known as the R.R.I. 1952 Collection and seedlings of the *Dothidella* resistant clone FX 25 which had suffered severe retardation in growth and some dieback in part of the nursery were made into clones by disbudding and will be established in a cubic lattice trial in 1954.

Seventeen *Dothidella* resistant clones, out of twentyfive clones which this Institute exchanged with the Instituto Agronomico do Norte, Belem, Para, Brazil for the same number of R.R.I. clones, have been successfully established in Malaya during the third quarter of 1953.

The budwood had been multiplied under quarantine conditions at the Plant Introduction Garden of the Division of Rubber Plant Investigations of the United States Department of Agriculture at Miami, Florida and was flown to Malaya via the Commonwealth Mycological Institute, Kew where it was examined and disinfected.

The first consignment of budwood of nine clones which was received in Kuala Lumpur on 1 July 1953 gave 87 per cent final budding successes and the second consignment of budwood of eight clones received in Kuala Lumpur on 29 September 1953 gave 86 per cent final successes. Budwood of the remaining seven 'exchange' clones will be despatched to Malaya during the summer of 1954.

A small scale trial of 237 clones made from legitimate seedlings of the 1951 hand pollination programme has been established on the R.R.I. Experiment Station during the last quarter of 1953. Thirtyfour of these clones have been budded in the north east corner of Field 52 and the balance of 203 clones along the eastern boundary of Field 56.

Twelve elite clones from research organisations in Malaya, Indonesia, Indochina and Ceylon, with clone RRIM 501 as control, have been established in a balanced incomplete block design trial of thirteen clones in Field 52, R.R.I. Experiment Station during the third quarter of 1953.

Observation plots of twenty-nine other non-R.R.I. clones which could not be included in the main trial were established in the same field in observation plots of four rows of ten points each.

Additions to the clone museum on the R.R.I. Experiment Station consisted of a clone of *Hevea guianensis* var. *collina*, five clones made from non-Wickham seedlings of a direct importation from Java and two early Java clones.

Clones LCB 870 (received from the Proefstations der C.P.V. Java) and clones RRIM 238, 239, 240 and 241 have been budded in the small scale trial in Field 56.

RRIM '600' Series

The RRIM '600' series clones in small scale trial continue in recording, those showing an increase in yield during 1953 are RRIM 600, 601, 602, 603, 607, 610, 611, 612, 615, 623, 629 and 630. Little change is shown by clones RRIM 605, 608, 614 and 623, the remaining clones showing a decrease in yield relative to 1952.

In the large scale trial the outstandingly vigorous clones are RRIM 603, 613, 621 and 623 and the least vigorous 609, 617 and 629.

In the large scale trial of clones RRIM 500 to RRIM 512, and clones RRIM 513 to RRIM 522, a year's tapping on renewed bark (at S/2.d/2.100% in most cases) was completed. In both sections of the trial the yield of the control clone Pil B84 showed a considerable drop while the majority of the clones under trial maintained their yield or fell very slightly. In consequence there is an apparent improvement over the control.

In fact in one section clone RRIM 501 yielded 2219 lb per acre per annum a slight decrease of 167 lb per acre per annum during 1953, clone RRIM 508 showed a spectacular increase by 537 lb to 1851 lb per acre per annum, and clone RRIM 511 maintained its yield at 1721 lb per acre per annum.

In the other section of the trial clone RRIM 513 increased its yield by 105 lb to give 2031 lb per acre per annum, while clone RRIM 520 remained at a steady yield of 1553 lb per acre per annum.

In the trial of clones RRIM 523 to 529 tapping was still on the second panel of virgin bark during 1953. The control clone Pil B84 showed an increase of yield of almost 200 lb per acre over the year to give 1366 lb per annum. Clone RRIM 526 yielded 2179 lb per acre per annum and clone RRIM 527 yielded 2066 lb per acre per annum, with a low percentage of brown bast casualties in both cases.

Method of Yield Prediction

A preliminary test tapping (P.T. test) has been made on trees of RRIM '600' series clones in large scale trial at the age of two years and ten month from budding. The procedure consists in making three standard incisions on each tree each on alternate days; the exuding latex being collected, dried and weighed. Twenty-one clones were included in the test which was carried out on fifty trees of each clone.

Analysis of variance of the balanced incomplete block lay out revealed highly significant clonal differences. The yields of the Preliminary Test of the large scale trial were compared with the girth at 40 inches and 60 inches in large scale trial and with the yields of the small clones in small scale trial. Each correlation coefficient was based on nineteen pairs of observations.

Correlations between girth at 40 inches and 60 inches with yields in small scale trial and yields of the preliminary test in large scale trial were all not significant, the only

significant correlation (at five per cent level) being between mean yields in small scale trial and mean P.T. yields in large scale trial.

The preliminary test has also been carried out on the seedlings of the 1951 hand pollination and on clones made from the 1949 hand pollinated seedlings.

Gunnery's findings (*J. Rubb. Res. Inst. Malaya* 6(1955)1) in 1935 of the relationship between sieve tube diameter and yield are being verified on bark samples of the legitimate seedlings of the 1949 and 1950 hand pollination programme.

In the 1949 seedlings (families 1 to 10) highly significant differences between families have been established, family No. 4 (RRIM 83 x RRIM 500) having the largest mean sieve tube diameter which is significantly better than that of the other families followed in order of merit by families No. 3 (RRIM 83 x RRIM 509), No. 5 (RRIM 83 x RRIM 507) and No. 8 (32/599 x RRIM 501). Family No. 7 (44/533 x Lun N) has the smallest mean sieve tube diameter.

In the 1950 seedlings (families 1 to 9) also highly significant differences have been shown between families. Family No. 6 (RRIM 600 x RRIM 500) showing the largest mean diameter and family No. 7 (RRIM 600 x RRIM 83) the smallest. Other families with sieve tubes of relatively large mean diameter are No. 9 (34/373 x TK 14), No. 3 (RRIM 600 x Tjir 1), No. 2 (34/373 x RRIM 600) and No. 8 (RRIM 610 x RRIM 507).

Bark samples have been collected from 233 seedlings of eleven families of the 1951 hand pollination programme, from two year old buddings made from seedlings of the 1949 hand pollination programme and from mature trees of RRIM '500' series clones and have been fixed in formalin-acetic-alcohol for sectioning and measurement of sieve tube diameter with a view to future recording and classification.

A re-examination of slides prepared by Gunnery was commenced, with a view to examining his classification into three groups, by measuring the sieve tube diameters. These slides are all from Tjikadoc seedlings in Field 2. Differences in the methods of staining and mounting may have given differences in readings.

Upkeep and routine records continued on all established and immature trials throughout the year.

Mr C. W. Brookson visited Sumatra East Coast from 14 February to 3 March. He visited six estates, the Algemeen Proefstation van de AVROS at Medan and the AVROS Test Gardens at Sungei Pantjoer, the object being to examine the latest high yielding clones developed in Sumatra with a view to possible exchange for R.R.I.M. clones.

PROPAGATION AND PLANTING TECHNIQUE

The optimum condition of young seedlings for use as stocks for budding has been re-investigated. There is cambial activity in a seedling when the first foliage leaves are spreading out but, so far, no results are available concerning the success or otherwise of budding at this stage.

Anatomical investigation has confirmed that in seedling stocks (up to three years old) easy peeling of the bark is due to, and is a sure sign of, activity of the cambium. Failure to peel was always found to be associated with an inactive cambium.

In the older seedlings the periods of minimal cambial activity at the stem base correspond to the phases of wintering and rapid extension of the young flush. The other phases of the stem apex cycle i.e. the hardening of the new flush and maturation

of the new leaves and terminal bud are periods of cambial activity. The cycle of activity is slightly ahead in the uppermost flushes compared with the base.

One may, therefore, anticipate that peeling of the bark, which is a prerequisite for budding and probably for the union of stock and scion will be best at these stages and this is in fact in accord with present budding practice on the R.R.I. Experiment Station.

The last xylem elements, especially the tracheids, formed in each growth cycle are radically compressed and dark staining. Thus rings are formed in the wood the number corresponding to the number of growth flushes or of leaf storeys.

Preliminary trials with budding of young hevea seedlings in the green stage gave a final budding success of fifteen per cent with seedlings six to eight weeks old from planting.

The highest percentage of budding successes, in which the grafted bud sprouted after cutting back of the stocks, was 56 per cent and the overall percentage of successes in all trials was 32 per cent. Dry weather during the first ten days after budding the very young material would appear to be fatal to the budding operation.

It would seem that within limits the larger the seedling stock the more rapid the scion growth presumably because the young seedlings have few reserves.

An experiment to test the effect of Phymone soluble powder on the establishment and early growth of budded stumps has confirmed the R.R.I. results of pre-war experiments with Hortomone 'A'.

The stumps which varied in girth from 5.1 to 11.3 inches were divided according to size into small and large stumps. Half the stumps in each group were completely deprived of lateral roots and in the other half of the stumps the lateral roots of the main whorl were pruned to about six inches from the tap root.

Equal numbers of stumps in the two categories were either treated with Phymone solution for eighteen hours or left standing in water for the same period before planting.

The most striking effect was that the grafted bud of the Phymone treated stumps rapidly swelled and the scion shoot elongated before those of the control stumps. However, this leadership was not maintained and three months after the beginning of the trial hardly any difference could be detected between the treated and control stumps. Large stumps also showed an initial advantage over small stumps which was later lost.

The retention of lateral roots showed no advantage at first but later showed an advantage which was maintained. It would appear from this trial that Phymone has similar properties to Hortomone 'A' and other synthetic growth substances in that it promotes a rapid start which is not maintained.

Numerous attempts to root leaf cuttings and young leafy shoots of hevea of different ages, with or without an axillary bud, have not been successful, the leaflets turning yellow and becoming detached one to two weeks after insertion in the rooting medium.

The rooting medium consisted of a 1 : 2 mixture of sand and peat moss and the cuttings were treated by the instantaneous dip method with a solution of a mixture in equal proportions (0.025 grams) of B indolyl butyric acid and naphthalene acetic acid in 10 cc of 50 per cent ethyl alcohol.

After the more successful attempts with leaf cuttings in 1949 and 1952 under green house conditions during the summer in England it would seem that the main factors

concerned may be the amount of food reserve contained in the leaf and/ or the length of day.

A miniature green house enabling a virtually saturated atmosphere to be maintained around the leaves will be used in further attempts to strike leaf cuttings of *Hevea*.

A method of rooting clonal stems by grafting buds from young seedlings on to the stem of young budded plants has been tried without success. In this method, described in *Turrialba* 1 (1951) 201, the grafted bud is made to shoot by cutting back the stem of the young budding which is then cut off, treated with growth substance and placed in a rooting medium of a propagating chamber.

A crown budding experiment to test the effect of the crown on the yield of the middle piece of double budded trees continues in progress. The first budding at the normal height was carried out in March 1952, the clones used being Tjir 1, BD 5, LCB 870 and a clone of *Hevea spruceana*.

Crown budding with the same clones at a height of six feet from the union was carried out in December 1953 and the results at opening of the 'first round' buddings show that the best overall successes (85 per cent) have been obtained on Tjir 1 panel clone and the worst results (42 per cent) on BD 5 panel clone.

The best results on all stocks have been obtained with the branch budwood of *Hevea spruceana* and nursery budwood of clone BD 5, Tjir 1 nursery budwood giving the poorest results.

Heavy losses are often experienced on inland soils when stumped buddings are used either as planting material in new clearings or as supplies in budded areas and some clones, e.g. Tjir 1, are notorious in this respect.

As the losses, for the most part, are caused by loss of water from the main stem of the stumped buddings any means which would prevent or even reduce this loss of water would be expected to increase the percentage of successes on transplanting.

Preliminary trials have shown an increased percentage of transplanting successes over the control by enclosing the stem within an alkathene tube, by wrapping with newspaper or painting with a preparation consisting of a mixture of latex with polymethyl methacrylate. Smearing the stem with vegetable oils or grease proved deleterious. Further trials are in progress.

Data from the density of planting experiment with clone AVROS 50 are being subjected to statistical analysis with a view to early publication of the results obtained up to the end of 1953.

Budding with clones RRIM 501, 513, 527 and LCB 1320 was carried out in May 1953 in the experiment designed to compare three hedge row spacings of 50 ft, 65ft and 80 ft with planting intervals along the rows to give three planting densities of approximately 150, 195 and 245 trees to the acre with forms of avenue planting giving an initial density of about 180 to the acre.

The trial of mixed planting of rubber and cocoa on the R.R.I. Experiment Station has been discontinued owing to the unsatisfactory growth of the cocoa plants. The area which is planted with hedge rows of rubber, one clone to each hedge row, will be treated according to plan as a seed garden and the cocoa plants which have survived will be allowed to remain.

TAPPING

Tapping and yield recording continued in seven tapping experiments on the R.R.I. Experiment Station and in seven experiments on estates. This represents an increase during the year of two tapping experiments on estates.

Work on the R.R.I. Experiment Station include two of the oldest experiments on full circumference tapping.

In the small scale experiment on unselected seedling trees, planted in October 1928, the half spiral alternate daily system $S/2.d/2.100\%$ is being compared with three full circumference systems. The results over the periods 1935 to 1940 and 1947 to 1953 show that the double cut periodic system with alternate daily tapping on two half spiral cuts, one on each side of the tree and 20 inches higher than the other, with three months' tapping followed by three months' rest ($2S/2.d/2.3m/6.100\%$) has yielded approximately the same as the control system $S/2.d/2.100\%$ while the double four system ($2S/2.d/4.100\%$) and the full spiral fourth daily system, ($S/1.d/4.100\%$) have yielded 15 per cent and 23 per cent respectively more than the control system. Tapping in all these systems was on second renewal bark during 1953.

In the experiment on budded trees of nine clones planted as budded stumps in 1929 a comparison of the double four system with the half circumference alternate daily system has been in progress since July 1937. The results over the full period for which yields are available show an overall drop of 14 per cent in yield relative to the half spiral alternative daily system, clone AVROS 50 showing a gain of 3 per cent and clones AVROS 49 and Pil A44 a loss of 34 per cent and 30 per cent respectively.

Of the other clones in the experiment AVROS 152 shows a loss of 5 per cent while clones BD 5, Pil B84, PB 23, PB 186 and Tjir 1 show, on the average, a loss of 13 per cent. The experiment in its original form was discontinued as from 1 May 1953 when half the number of trees of each clone were treated with a yield stimulant in order to find the reaction of the individual clones to such treatment.

The results for the first six years of continuous tapping in another experiment set up on mixed buddings of sixteen clones, budded in 1932, for a direct comparison of the half spiral alternate daily system and the full spiral fourth daily system showed a difference of 1.2 lb of total dry rubber per tree per year in favour of the former system. The trees tapped on the full spiral fourth daily system have lost 0.8 inch in mean girth relative to those tapped alternate daily on a half spiral cut and the lower grade rubber is about 3.5 per cent higher.

A comparison of the full spiral fourth daily continuous system ($S/1.d/4.100\%$) with full spiral periodic systems of 67 per cent intensity ($S/1.d/4.8m/12$ and $S/1.d/4.12m/18$) and of 75 per cent intensity ($S/1.d/4.12m/16$ and $S/1.d/4.18m/24$) on budded trees of seven clones, budded in 1931, has shown over a period of five years marked differences in the response of the clones to the periodic systems, clone Tjir 16 showing the best response giving 93 per cent of the yield of the continuous full spiral fourth daily system and clone AVROS 50 giving, on the periodic systems, only 57 per cent of the yield of the control system. The results show no advantage of six months' rest over four months' rest.

A small scale trial on the same clones and on trees of the same age to investigate the effect of extending the interval between tappings on a full spiral cut from four days to five or six days shows, over a period of five years, a gradual increase each year in yield relative to the control system ($S/1.d/4.100\%$) in the full spiral systems with five days ($S/1.d/5.80\%$) or six days ($S/1.d/6.67\%$) between tappings, the yields in the fifth year being about 15 per cent in excess of the tapping intensity. Bark consumption per tapping increases with the increased intervals between tappings.

Results for the first four years of tapping in an experiment on mixed buddings of five clones, budded in 1932, to compare three full spiral systems of 100 per cent intensity and the half spiral alternate daily system show that the best yield per tree per year (23.1 lb) has been obtained in the full spiral fourth daily continuous system.

The full spiral third daily periodic system with nine months' tapping followed by three months' rest (S/1.d/3.9m/12.100%) has yielded an average of 22 lb per tree per year while the full spiral alternate daily periodic system with two months' tapping followed by two months' rest (S/1.d/2.2m/4.100%) has yielded 20.7 lb per tree compared with a yield of 21.3 lb per tree in the half spiral alternate daily system used as a control.

A simple comparison of the 'standard' system of alternate daily tapping on a half circumference and a system used on smallholdings in which the trees are tapped daily on a third circumference cut on about 24 days in each month (S/3.d/1.24d/30.107%) is provided in a small scale experiment set up in January 1949 on mixed buddings of clones Tjir 1 and Pil B84 on a former smallholding.

The results over a period of five years show an advantage in yield of 18 per cent for the smallholders' system which, however, has a monthly bark consumption of 1.3 inches compared with that of 0.9 inch in the S/2.d/2.100% system. The yearly girth increment is the same in both systems.

Tapping Experiments on Estates

Three tapping experiments comparing full circumference systems with the half circumference alternate daily system were super-imposed on standard clones trial in R.R.I. experimental planting on three estates after the war.

In the first experiment on an estate situated on coastal alluvial clay soil with peat, the planting material consists of buddings of clones Pil B84 and D65, PB 86 and 186, Gl 1 and BD 5 budded in 1938. The full spiral fourth daily system (S/1.d/4.100%) is compared with the standard half spiral alternate daily system (S/2.d/2.100%) and the results over a period of six years show for all clones a slight advantage in yield of 8 per cent in the former system, clone Gl 1 showing a loss of yield of 7 per cent and clone Pil D65 an increase in yield of 16 per cent on the S/1.d/4.100% system. The average girth is 1.4 inches less in the full spiral fourth daily system.

Brown bast incidence is higher in the half spiral alternate daily system with clone Gl 1 showing an incidence of 25 per cent compared with 17 per cent in full spiral fourth daily system.

The second experiment, also on coastal soil and on the same six clones compares the full spiral fourth daily system (S/1.d/4.100%), the double four system (2/S/2.d/4.100%) and the half spiral alternate daily system (S/2.d/2.100%).

The best yielding clones are shown to be Gl 1 and PB 86 which over the five year period (1948-1953) have yielded 38 per cent and 31 per cent respectively more than the control Pil B84 and this despite the fact that clone Gl 1 has been tapped at reduced intensity (S/3.d/2.67%) since 1 July 1950.

Although there are differences between clones in their responses to the full circumference systems, the average result for all clones has been a loss of yield of about 6 per cent in the double fourth daily system, and one of 10 per cent in the full spiral fourth daily system.

Clone Gl 1 has given the poorest response to full circumference tapping. The full circumference systems have resulted in a greater retardation of growth.

The third experiment on an inland soil provides for a straight comparison of the S/1.d/4.100% and the S/2.d/2.100% systems on trees of clones Tjir 1 and 16, Pil B84 and D65 and PB 86 budded in 1939. The results for the first six years of tapping show on the average a loss of yield of 10 per cent in the full spiral fourth daily system, clone

Tjir 1 being the least affected (loss of 3 per cent) and clones Tjir 16 and Pil B84 the most affected (loss of 30 per cent). The average girth in 1953 is 1.2 inches less in the full spiral fourth daily system.

The excellent performance of clone Tjir 16 on the S/2.d/2.100% system in this experiment is noteworthy, the clone having outyielded both clones Tjir 1 and PB 86 over the full period of six years.

An experiment to study the periodic change over of tapping panels on young budded trees tapped alternate daily on a half spiral cut and the effects of different periods of tapping and of rest was set up in April 1950 on an estate in an area of 38 acres budded with clone Tjir 1 in 1941.

The tapping treatments consist of three half spiral alternate daily systems of 100 per cent intensity, three full spiral systems of 100 per cent intensity, three full spiral fourth daily periodic systems of 75 per cent intensity, three full spiral fourth daily periodic systems of 67 per cent intensity and three full spiral third daily periodic systems of 100 per cent intensity.

As the periodic systems with 32 months' tapping followed by 16 months' rest or with 36 months' tapping followed by 12 months' rest have not yet derived their full benefit from the rest, the period covered by this experiment is too short for detailed comments but several points of interest may be noted.

All tapping systems have in the first two years yielded in excess of their relative intensity. The best renewal over the period of three years has been obtained in the full spiral systems. No trend has yet been observed in the girth measurements. Brown bast incidence has been negligible in the full spiral systems and in the half spiral alternate daily systems there is a suggestion that the incidence is less in the changeover system than in the continuous system. Tapping costs in the full spiral systems have been about two thirds of those on the half spiral systems.

An experiment was started during the year on a collaborating estate to find the most economic tapping system for clone Gl 1 a clone which is capable of very high yields but which shows a high brown bast incidence when tapped continuously at 100 per cent intensity. There is some indication that the alarming downward yield trend and high incidence of dry trees on the half spiral alternate daily system (S/2.d/2.100%) may be overcome by the introduction of a changeover tapping system whereby a half spiral cut is tapped alternate daily with six months out of twelve, or twelve months out of twentyfour, each of two alternate panels (S/2.d/2.2x6m/12.100% or S/2.d/2.2x12m/24.100%).

These two systems have been included in the experiment together with another changeover system in which each half spiral cut is tapped third daily with twelve months out of twentyfour on each of two alternate panels (S/2.d/3.2x12m/24.67%) and with the half spiral third daily system (S/2.d/3.67%).

Tapping and yield recording commenced in October 1953 in the experimental area of 32 acres budded in 1947 with clone Gl 1 on an estate situated on coastal alluvial clay soil.

Enquiries are being made to find a suitable young replanted area for a similar tapping experiment on clonal seedlings with the object of checking the relatively high incidence of brown bast without causing an appreciable loss of crop.

Slaughter Tapping

A slaughter tapping experiment, described in the annual Report for 1952, which included seven tapping treatments and upward tapping was carried out during 1952 on 23 years old clonal seedling trees on the R.R.I. Experiment Station.

Systems of 200, 267 and 400 per cent intensity with tapping on a full circumference downwards on renewed bark and upwards on virgin bark were used with and without application of a yield stimulant to the bark. The results over a period of one year showed that multiple cut systems of 200 per cent intensity could be made to yield as much as systems of 267 per cent intensity by treatment with a yield stimulant.

The use of a yield stimulant on trees tapped on systems of 267 and 400 per cent intensity did not result in an appreciable increase in yield.

Another experiment of a similar tree plot design was started during the year on well grown 45 years old unselected seedling trees on a collaborating estate. After one month of recording 'pre-treatment' yields the tapping treatments were applied and individual tree yields recorded by coagulation of the latex in the cups as from 3 June 1953.

The treatments consist of (a) three half circumference V cuts, two cuts opened on virgin bark at the junction with renewed bark and tapped upwards and one cut tapped downwards on renewed bark, every fourth day ($3V/2.d/4.150\%$), (b) of four half circumference V cuts, two on virgin bark tapped upwards and two on renewed bark tapped downwards, every fourth day ($4V/2.d/4.200\%$) and (c) of three half circumference V cuts as in (a) but tapped alternate daily ($3V/2.d/2.300\%$) with the half circumference alternate daily system ($V/2.d/2.100\%$) as control, all systems being used with and without the application of a yield stimulant on to a three inch strip of lightly scraped bark immediately below the downward tapped cuts and above the upward tapped cuts. All cuts on each tree are tapped on the same day, the upward tapped cuts necessitating the use of short ladders.

The results after four months, and before the second application of the yield stimulant, show the superiority of the $3V/2.d/2.300\%$ system which is further enhanced by the yield stimulant and there seems little doubt that the trees will be able to stand up to this intensive tapping at 300 per cent intensity for the full year before they are cut out for replanting.

Systems (a) and (b) of 150 and 200 per cent intensity respectively combined with yield stimulant treatment, have yielded only little less than system (c) of 300 per cent intensity and with no yield stimulant treatment.

The increased yields in all tapping treatments brought about by the yield stimulant are mainly from the upward tapped cuts on virgin bark and treatment of old and thin renewed bark is in most cases not an economic proposition.

The results confirm the main conclusion from the previous experiment that the effect of a yield stimulant is short lived when it is combined with a high intensity slaughter tapping system.

High Tapping

The decline in yield in the third tapping cycle on bark of second renewal of high yielding planting material has been generally experienced during the year and in some cases accounted for about 40 per cent loss of crop in both budded and seedling areas.

Many estates resorted to high (ladder) tapping on virgin bark on cuts opened at seven to eight feet from the ground or union and more than made up for the drop in yield on second renewal bark, increases of the order of 50 to 80 per cent being reported from some estates.

PHYSIOLOGY

The results of two tapping experiments carried out for periods of 16 to 45 months respectively which were concluded during the year have shown that tapping to the wood on a full spiral cut (treatment 1) causes a loss of yield of about 25 per cent and appears to check downward translocation of plant food. Tapping the full spiral cut to normal depth but joining the ends of the cut by a vertical cut to the wood (treatment 2) has no significant effect on yield.

Complete ringing by tapping to the wood on the full spiral cut and joining the ends of the cut by a vertical cut to the wood (a combination of treatments 1 and 2) results in a large and progressive decrease in yield and, considered with treatment 2, provides evidence of a lateral translocation when the normal channels of conduction are severed.

Tissue culture experiments with hevea were carried out during the year in an attempt to provide suitable material for a study of factors affecting the synthesis of latex.

Some 30 to 40 callus tissue cultures from the main stem of two week old hevea seedlings have been obtained but so far all have failed to be sub-cultured — in all cases due to infection.

Cambium tissue has been grown successfully when excised aseptically from a mature tree and placed in culture medium, but again the rate of infection is very high.

Experiments with hevea seed provided some evidence of a fungus infection which exists between the seed coat and the perisperm. This has necessitated the removal of the seed coat before surface sterilization. One per cent Bromine water has been found to be the best surface sterilizing agent for seeds. Mercuric chloride at a strength of 0.1 per cent in 50 per cent alcohol gave a low incidence of germination while 7 per cent bleaching powder solution with Teepol added as a wetting agent allowed a high rate of initial infection.

Excised adventitious roots and tap roots of hevea have so far resisted attempts to establish unlimited growth in culture. Tap roots have continued to grow for several weeks but only with a gradual diminution in size of meristem. A semi solid medium seems one of the essential factors since a liquid medium failed to support growth, while the addition of 1.2 per cent agar permitted growth for three weeks.

Following on the work of Pyke and Gooding at this Institute a study of the effect of growth hormones on the flow of latex was started. It was found that a proprietary growth hormone paste when applied below the tapping cut did not alter the pattern of dilution at any of the points tested i.e. from ground level to ten feet above the tapping panel. Dilution was found at all points tested below the tapping cut and up to three feet above. Latex was not drawn from the highest point tested. There was evidence that the taking of numerous samples from a small area of bark caused local dilution and affected the results.

Using normal and 2,4-D sprayed seedlings the activity of enzymes was investigated. 2,4-D in concentrations of 50, 100, 250 and 500 p.p.m. caused an increased activity of polyphenol oxidase and peroxidase in the roots but eliminated it from leaves and stem. There was increased invertase activity with 100 and 500 p.p.m. 2,4-D in the stems. Catalase was suppressed in the leaves of sprayed plants. A 250 p.p.m. 2,4-D spray was lethal to four month old seedlings while a 500 p.p.m. paste killed eighteen month old plants.

2,4-D at concentrations of 100 p.p.m. was found to cause increased water uptake by leaf discs, but similar experiments with bark discs gave indecisive results.

Stimulation of Yield

The experiments described in the Report of the Botanical Division for 1952 were continued during the year.

In an experiment carried out on unselected seedling trees planted in 1931 yield increases of the order of 35 to 40 per cent over a period of four months were obtained by treating a three inch strip of lightly scraped bark below the tapping cut with a one per cent solution in palm oil of the normal butyl ester of 2,4-D and of 2,4,5-T and with a proprietary yield stimulant. The light scraping treatment resulted in a 15 per cent increase in yield over the period.

In another experiment carried out on illegitimate seedlings of four clones planted in 1931 the superiority of 2,4,5-T over 2,4-D as a yield stimulant was demonstrated for the first time, the sodium salts being used in a water palm oil emulsion and the normal butyl esters as a solution in palm oil.

The oil solutions of 2,4-D and 2,4,5-T were clearly superior to the emulsions as yield stimulants, yield increases of the order of 50 per cent being obtained over a period of six months following treatment with a one per cent solution in palm oil of the normal butyl ester of 2,4,5-T and of 20 per cent with injection of powdered copper sulphate at the rate of 10 grams per tree. Treatment of the lightly scraped bark surface with palm oil resulted in a 12 per cent increase of yield during the same period.

An experiment to verify the findings of our pre-war experiments on old seedling trees in which large increases in yield were obtained by a light scraping of a twelve inch strip of bark below the tapping cut has shown over a period of three months an increase of about 12 per cent which was raised to about 18 per cent by the application of palm oil to the scraped surface. Failure to confirm the pre-war result is ascribed to the thin and corrugated condition of the renewed bark which made light scraping difficult without fairly extensive wounding.

The poor response of the thin bark to treatment is also shown by the trees treated on a three inch strip of scraped bark with a yield stimulant which gave a yield increase of 40 per cent for the first month following treatment after which the yields returned to normal.

An experiment carried out in an area of clone AVROS 50 in which a very low yield level was associated with an anatomical abnormality of the bark characterised by the presence in super abundance of stone cells and of calcium oxalate crystals in the soft bast has shown over a period of six months that the half circumference tapping cuts at normal levels treated with a yield stimulant yield less than those opened in virgin bark at 50 inches above the level of the old panels, originally opened at 40 inches above the union, and that the best results are obtained by treating the high cuts with a yield stimulant.

In a small scale experiment on buddings of nine clones tapped on two different tapping systems of 100 per cent intensity treatment of second renewal bark with a yield stimulant resulted over a period of six months in an overall increase of 33 per cent in the half spiral alternate daily (S/2.d/2.) system and of 41 per cent in the double four (2S/2.d/4.) system, the difference being small despite the fact that double the number of cuts were treated in the 2S/2.d/4 system.

Clones varied in their response to the yield stimulant. In the S/2.d/2 system clones Pil A44 and BD 5 showed the best response with a 60 per cent increase in yield and clones Pil BS4 and PB 186 the smallest response with a 10 per cent increase.

In the 2S/2.d/4. system clone AVROS 152 showed an 87 per cent increase in yield compared with one of 27 per cent for clone Pil B84 during the same period.

The results to date of all yield stimulation experiments are being prepared for publication in the *Journal of the R.R.I. of Malaya*.

Stimulation of Bark Renewal

Sebacid acid, glutathione and thiourea have been tested for their effects on bark renewal. The chemicals were applied to bark immediately above the tapping cut of fifteen years old trees as water-in-oil emulsions at concentrations of 0.001, 0.01, 0.1, 1 and 10 per cent. Measurements of bark thickness taken at quarterly intervals over a period of two years have shown no significant effect of any of the treatments on the rate of bark renewal.

In an experiment on 24 years old trees of clone AVROS 50 in a density of planting experiment on the R.R.I. Experiment Station a monthly application of each of eleven mixtures has been made to one inch strip of newly tapped second renewal bark immediately above the tapping cut and it was found that two treatments comprising a proprietary yield stimulant and one per cent solution of the normal butyl ester of 2,4-D in palm oil respectively have a clear stimulating effect on the yield. The relative increase in the yield per tree is highest in the most densely planted systems where the trees have a relatively low yield.

ECOLOGY

The plant taxonomist has studied the literature concerning the natural distribution and taxonomy of hevea and the information has been tabulated under the headings: Specific descriptions, range, habitat, economic value and disease resistance.

Various wet collection methods for plant material have been tried including formalin, alcohol and 8-hydroxyquinoline sulphate solution. The use of the chemicals is to enable plant material to be kept damp without decay when time and facilities for careful drying and mounting are not available.

Immersion of the plant specimen for a few minutes in industrial methylated spirits as soon as possible after collection and before the leaves are badly wilted was found to be very practical. The tissues are killed thus reducing leaf abscission and destroying moulds and insects and causing little colour change.

The prospective land addition to the R.R.I. Experiment Station to be cleared from jungle in 1954 (about 70 acres) for the establishment of trials of new clones has been inspected by the taxonomist and the Assistant Botanist who have made a broad study of the present vegetation in this forest reserve. It is proposed to carry out an ecological survey in the area within the four vegetation types which have been recognised, specimens of all plant species to be collected and identified.

Routine work under this section during the year has consisted of the identification and mounting of 89 specimens which were added to the Division herbarium and the identification of 74 cover plants received from estates. The assistance of the Director, Singapore Gardens for the identification of a number of these plants is gratefully acknowledged.

Five pounds of seed of the leguminous bush cover *Flemingia congesta* have been supplied to the R.R.I. of Ceylon. Considerable interest was evinced in this bush cover and the seed issued during the year consisted of two pounds to a large Planting Company and samples weighing approximately six ounces to each of 46 estates.

The number of germination tests carried out on leguminous cover crop seed during the year was twentyfive.

Experimental Planting on Estates

Tapping and yield recording continued in experimental areas during the year. The results for the first five years of tapping in trials of standard clones, R.R.I. clones and clonal seedling families have been analysed statistically and a full report now in course of preparation will be published shortly in the *Journal of the R.R.I. of Malaya*.

The RRIM '600' series clones are being tested in sixteen large scale trials on estates. These trials range from 13 to 53 acres each and contain 9 to 21 clones. Four of the large scale trials were established during 1953. In addition, 24 small blocks each covering 2.5 acres and containing four '600' series clones and a control of clone RRIM 501 have been distributed among estates. The aggregated information from these twentyfour blocks scattered on various estates will roughly correspond to two of the large scale trials.

Eightyone estates spread over six States of the Federation of Malay have purchased budwood of a number of the RRIM '600' series clones for testing on an experimental scale.

Export of Budwood of R.R.I. Clones to Countries Contributing to the Malayan Rubber Fund

Budwood of eighteen of the RRIM '600' series clones (two yards of each clone) was despatched to the Department of Agriculture Nigeria and of thirtyone '600' series clones (131 yards) and of two '500' series clones (14 yards) to the Rubber Fund Board, North Borneo during the year.

Estates in North Borneo also received budwood of RRI clones 501 (27 yards), 513 (17 yards) and 526 (5 yards) and of a selection of '600' series clones 600 to 623 (319 yards).

Five yards each of budwood of R.R.I. clones 600 to 630 were despatched to the Department of Agriculture, Sarawak for multiplication and distribution in that territory.

ADVISORY WORK

A large increase in the volume of correspondence received in the Division, the highest on record and representing an increase of approximately 25 per cent over 1952, occurred during the year.

The trend of activities from 1950 onwards is shown in the following analysis.

	1950	1951	1952	1953
Letters received	1093	924	1484	1802
Visitors to Division	79	48	89	75
Visits to Estates	73	21	49	122
Samples received for examination or identification	27	21	76	93

An analysis of the advisory correspondence under the major sections of the Botanical Division research programme with the object of showing the relative importance of the principal subjects of enquiry is given in the following review.

The number of letters despatched in reply to enquiries was 1128 of which 916 were of a purely advisory nature.

Breeding and Selection

Fiftythree enquiries concerning the design of seed gardens and the selection of budded areas for the collection of clonal seed were received. Seventeen seed samples have been examined and identified in connexion with the selection of seed collection areas.

Propagation and Planting Technique

Enquiries relating to the choice of planting material have been the most numerous and are shown below separately from enquiries on replanting and on general planting topics.

Choice of planting material (clones and clonal seedlings)	338
Replanting	55
General planting topics	111

The general planting topics include tree poisoning, planting distances, hedge planting, growth in replanted areas and nursery methods.

Tapping

Enquiries under this heading which comprises also slaughter tapping and ladder tapping reached a record level of 123, and 162 letters were received on the subject of commercial yields of buddings and clonal seedlings.

A number of estates were advised on the height of opening and task size for ladder tapping, the information being derived from an experiment carried out by the Institute on seedling trees with insufficiently renewed bark as early as 1929.

Physiology

The interest in yield stimulants continued unabated, the number of enquiries by letter during the year totalling 77.

A note on the preparation and use of the new yield stimulant 2,4,5-trichlorophenoxy-acetic acid (2,4,5-T) was prepared for use in reply to enquiries on yield stimulation, the superiority of 2,4,5-T over 2,4-D (2,4 dichlorophenoxy acetic acid) having been demonstrated for the first time in experiments carried out on the R.R.I. Experiment Station.

Experiments on seedling trees planted in 1931 have revealed no harmful effects of five successive treatments with yield stimulants applied to the bark at intervals of six months.

Ecology

Routine advisory work under this section has consisted in the identification of 74 plant specimens received from estates and of the preparation of 89 mounted specimens for the Division herbarium.

Twentyfive germination tests were carried out on commercial seed samples of leguminous creeping covers. A note on the treatment of leguminous cover crop seed for the improvement of germination was revised for use in advisory correspondence.

General Planting Enquiries

Senior members of the Division paid 153 visits to estates of which 36 were of a purely advisory nature.

Thirtyfour estates were visited by two members of the Junior Staff for purposes of identification of clones in the multiplication nursery or in the field.

Visitors

Seventyfive visitors, mainly planters, were received in the Division and thirteen were taken round the R.R.I. Experiment Station by members of the Division. The information sought was concerned mainly with choice of planting material and to a lesser extent with yield stimulation and ladder tapping.

E. D. C. BAPTIST
Head of Botanical Division

Pathological Division

The Head of Division Dr A. Newsam, the Assistant Pathologist Mr K. P. John and the Assistant Entomologist Mr B. S. Rao were on duty throughout the year. The Field Research Officer, Mr F. W. Hutchison, returned from long leave in April; the Pathologist, Mr R. N. Hilton, in September. The vacancy for a Microbiologist to work on pathological problems was filled in January with the appointment of Mr R. A. Fox, for whom a year's course of specialised training in the United Kingdom was arranged.

In November Dr A. Newsam visited Ceylon to attend a Replanting Conference held at Colombo under the auspices of the Rubber Research Institute of Ceylon. He presented a paper entitled '*Fomes lignosus* in Replanted Areas.'

Four lectures were delivered to local branches of the Incorporated Society of Planters, details being as follows:

'Termites and Borers' on 13 July in Ipoh and 22 October in Kulim and Sungei Patani, 'Spraying from the Air' on 18 October in Klang and 'Windborne Diseases' on 26 October in Seremban.

Four advisory leaflets were replaced by articles in Planters' Bulletin, the titles being: 'Control of Root Disease in Young Rubber' (*Planters' Bulletin* 4); 'Inoculation of Cover Crop Seed' (*Planters' Bulletin* 5); 'Mouldy Rot' (*Planters' Bulletin* 6); 'The Yellow Tea Mite' (*Planters' Bulletin* 8).

Two short articles — 'Black Stripe' and 'Anthracnose' — were published in *Planters' Bulletin* 8. The editorial in this issue was concerned with the development of an eradicant campaign for South American leaf blight.

RESEARCH

DISEASES OF THE ROOT SYSTEM

The two large scale field experiments designed to answer many practical questions in relation to replanting are in progress: G 50, laid down in 1950 on an inland soil; CI 51, on a coastal site, laid down in 1951. Observations on the rate of death of roots following different tree and stump preplanting treatments were discussed last year. There are good reasons for thinking that the known effectiveness of poisoning the old stand in reducing root disease in the replanting depends on killing the roots quickly. The next step depends on accumulating incidence figures and costs of control over several years. It would not be fruitful to analyse the information obtained so far.

The first round of inspection and treatment has been carried out for experiment CI 51, and the second round for G 50. The latter alone calls for comment. In the first round, carried out in 1952, shortage of labour precluded carrying out the intended complete eradication of discovered sources of infection. They were mostly old rubber stumps. All that was possible was to remove and burn diseased lateral roots on the side where the contact infection occurred, leaving the bole partially isolated. When the second round was carried out it was considered that the method merited further study as partial eradication would seem to dispose of most of the infective material at a fraction of the cost of getting the bole of the tree out. The modified treatment was

therefore continued over half the experimental area. Over the other half complete eradication was carried out, including the removal and burning of infective stumps discovered in the first round.

The last Report, in discussing antagonism between common fungi and the root disease parasite *Fomes lignosus*, made reference to inconclusive results with *Botryodiplodia theobromae*. The position reached in 1952 was that the reduced growth rate of *F. lignosus* in the presence of *B. theobromae* culture filtrates could have been due to antibiotic production by the latter or to a change being brought about in the hydrogen ion concentration of its substrate. To resolve the doubt *B. theobromae* was grown in cultures that were initially either acid or slightly alkaline. Each filtrate was divided into two parts, one used as it was, the other after the hydrogen ion concentration had been adjusted back to its original value — making it the same as the control solution. Pronounced differences in the rate of growth of *F. lignosus* in culture media containing the various filtrates and control solutions showed that *B. theobromae* had produced inhibitory substances, and that more was produced in the acid medium.

Some attention was given to sampling different soil types to study the quantity and composition of the microflora. Very variable results were obtained even with soil that appeared to be uniform. The investigation was not pursued, but one observation is perhaps worth recording. Estimates of the abundance of fungi and bacteria at progressive inch depths showed the fungi to be most numerous at the surface, about half being in the top two or three inches of soil, while the numbers of bacteria increased down to a depth, after compression, of five inches.

Observations on the viability of the major root parasites in buried pieces of root of selected sizes have been continued to the thirtieth month. Both *Fomes lignosus* and *F. noxius* were still alive in roots two inches in diameter and two feet long, and in those three inches in diameter and one foot long, that is, in root segments originally of volume 75 to 85 cubic inches. *Ganoderma pseudoferreum* had persisted also in roots two inches in diameter and only one foot long. Viability means that the fungus could be seen growing on the surface of the root or was isolated from it. It does not mean that the root fragment would necessarily still be infective.

Bearing in mind the important effect that legume cover crops have been shown to have on root disease incidence in young rubber, it is surprising how little is recorded of their relative susceptibility and the course of infection. Inoculation experiments have been started in a cover crop nursery.

In 1950 the cut surfaces of unpoisoned stumps on the Experiment Station were sprayed with a suspension of *F. lignosus* spores. The stumps subsequently became covered with a heavy growth of belukar. On clearing the area for replanting, two stumps that were found infected with the disease were closely examined to find the direction of its spread. Infection had started at the cut surface — it may be supposed as a result of inoculation with the spore suspension. The observations thus provide additional support for the contention that the stumps of healthy trees can become infected by windborne spores.

DISEASES OF THE TAPPING PANEL

Mouldy rot—The testing of a fungicide for the control of mouldy rot involves three stages: first, an *in vitro* test against the fungus; second, bark burning tests on clonal trees; third, field trials at concentrations chosen from the results of the two earlier tests.

Preliminary tests have been carried out with the following materials. Paranitrophenol, a water soluble fungicide sometimes used for preventing mould growth in sheet rubber,

gave complete inhibition of *Ceratostomella fimbriata* at 0.5%, at which concentration it is harmless to bark. Dioctyl sodium sulphosuccinate, a surface active agent sent to us by Dr J. T. Martin of Long Ashton Research Station, gave a like result. A quaternary ammonium compound supplied under a code number was effective and safe at a tenth the concentration. Two proprietary tar acid fungicides were also tested.

Field trials planned for the wet season towards the end of the year were frustrated by the weather not allowing a sufficient intensity of disease to build up. The need for suitable experimental sites is keenly felt, to try out in the field not only the materials listed above, but also others that passed preliminary tests in 1952.

Proprietary fungicides approved for the treatment of mouldy rot were reviewed by the Governments of the Federation and Singapore, and an up-to-date list issued. The revision was necessitated by certain materials having been dropped from the market.

Black stripe—The fungus *Phytophthora palmivora*, causing black stripe disease of the tapping panel, penetrates not only the bark and cambium but also a superficial layer of wood. Because it spreads fastest along the wood vessels there arise the characteristic black lines that are seen when the bark is removed. This amount of penetration has made it appear unlikely that fungicidal applications to the surface of the bark could clear up an infection, though they could prevent new ones starting. In Indochina, where the disease is worse than in Malaya, cutting out diseased tissue has been regarded as a necessary step in curative treatment.

An opportunity arose to try the effect of applications every tapping day of a fungicide (10% Killgerm) as a prophylactic treatment on uninfected trees, and as a curative treatment — with and without excision — on diseased trees. The experiment showed *Phytophthora* to be highly susceptible to the fungicide under dry conditions, but while wet weather lasted the treatments achieved little. Excision of diseased tissues, where the disease was active near the cut, gave so little improvement over the fungicidal treatment alone that it could not be justified. There was also found to be not much advantage in stopping tapping. The results indicate that infected trees should be treated with a fungicide during wet weather and on into the dry season until the disease is cleared up. Surgery is justified only to the extent of getting rid of any large burrs that have formed on the panel.

SECONDARY LEAF FALL

The distribution of outbreaks of secondary leaf fall reported during the first six months of the year in response to the annually distributed circular is shown in the first Table. No reports were received during January or June, nor from Kelantan at any time. The season was short, the great majority of cases being brought to our notice during March.

DISTRIBUTION OF KNOWN OUTBREAKS OF SECONDARY LEAF FALL

Territory	Outbreaks				Totals
	February	March	April	May	
Kedah	1	14	1	1	17
Penang & P.W	—	2	—	—	2
Perak	—	10	4	—	14
Selangor	2	11	1	—	14
N. Sembilan	3	16	—	—	19
Malacca	3	7	—	—	10
Johore	1	8	—	—	9
Pahang	—	1	—	—	1
Trengganu	—	3	—	—	3
Totals	10	72	6	1	89

Examination of 286 specimens sent in gave the results summarised in the second Table, from which *Oidium* is seen to occupy its usual place as the dominant parasite. The last column is arrived at by scoring the parasites according to a scale of five intensities of attack and averaging over the numbers of specimens attacked by each. The

INCIDENCE OF THE PARASITES ASSOCIATED WITH CASES OF SECONDARY LEAF FALL

Parasite	Percentage present	Cases in which unassociated	Mean intensity of attack
<i>Oidium heveae</i>	93	14.0	2.2
<i>Hemitarsonemus latus</i>	71	1.0	2.1
<i>Gloeosporium alborubrum</i>	29	1.0	2.2
<i>Scirtothrips dorsalis</i>	46	0.4	1.4

figures show that thrips are of less importance than their frequency of observation suggests; in fact they contribute least to the causation of secondary leaf fall.

Four reports were received during the second half of the year, all predominantly due to *Gloeosporium*.

PROTECTION AGAINST SOUTH AMERICAN LEAF BLIGHT

Aerial spraying trials with defoliants—The project to work out an eradicant campaign against South American leaf blight led to aerial spraying trials with defoliants being started in 1952. From the early results it was planned to investigate rates of deposit above one gallon per acre, but this had to be postponed because of delays in obtaining a pump of new design and larger capacity. It is now available; also rotary brush spray gear which has been fitted to the same aircraft and subjected to preliminary assessment trials.

Two further experiments have been carried out with the boom and nozzle equipment used in 1952. As both areas were scheduled for replanting later in the year, observations had to be confined to the months between the end of the annual refoliation and the time when the trees were poisoned.

The first experiment, on flat land, was made to observe the effects of one, two and three applications of the defoliant at concentrations of 5%, 7% and 10% of normal butyl 2,4,5-trichlorophenoxy acetate in Shell Diesoline. Early indications were that effectiveness increased with increased dosage, and this continued to be so up to the time of the last observations, ten weeks after the last application. The amount of leaf present in the 7% and 10% areas was similar, the difference between them being mostly in the extent of defoliation that had earlier taken place. The lowest concentration gave distinctly inferior results. At the low dosage of only one gallon per acre a repeat application was necessary every month, even with the higher concentrations, to keep the trees nearly leafless.

The second experiment was carried out over a hilly site to see how well the technique worked out over flat land could be applied in hilly country. The area selected included three moderately high hills — the highest being 200 feet — with steep and gentle slopes. The manoeuvrability of the Beaver made it possible to follow fairly closely the slope of the hills. It was decided, therefore, to compare the ground recovery for a level spray run at approximately 280 feet (30 feet above the highest tree tops)

with that from a run flying as nearly as possible 30 feet above the trees. No important difference could be detected but the variability among sampling papers was too great for an accurate comparison to be made. The runs with coloured oil were followed by application of the defoliant spray by both level and undulating flight, in order to be able to judge the relative coverage obtained by the resulting defoliation. The area was sprayed once with 10% of the ester, at the rate of one gallon per acre. Little refoliation had taken place up to twelve weeks after treatment, the effects being indistinguishable whether flying level or the undulating course following the slopes of the hills. Both methods gave good coverage and nearly complete defoliation.

STEM AND BRANCH DISEASES

Pink disease—An outbreak of pink disease on five-year-old trees on the Experiment Station during a period of exceptionally wet weather provided an opportunity of studying control measures under conditions favourable to the fungus. Fungicidal applications were combined with three prior treatments: first, pruning all diseased tissue, in which case the materials were required as wound dressings only; second, pruning dead branches and scraping away infected bark; third, pruning dead branches without scraping infected bark. The trees were inspected every week and applications repeated as found necessary. The least satisfactory treatment was an asphalt-kerosene mixture containing 5% of a proprietary wood preservative. The mixture has long been recommended as a wound dressing, for which purpose it is suitable, but it is found to be not active enough to kill the fungus in the underlying bark or wood. Fylomac 90 controlled the disease when used at 0.5%. At this concentration it is more expensive than Bordeaux mixture, which gave equally good results and has the added advantage of not burning leaves. It can therefore be sprayed on. The last treatment was a proprietary petroleum base wound dressing which contains a fungicide. It was effective but relatively slow to apply; further, it was liable to cause bark burning where the canopy was thin and the branches exposed to full sunlight.

TERMITES

Control measures that have been employed over the years for termites attacking trees of all ages have had one factor in common — that they do not destroy the pests but are more or less successful in driving them away from attacked trees. The materials used have been either insecticides or general poisons. As their function seems to be repellent, attention was given to the possibility of finding purely repellent substances that might be cheaper in use. Of six materials selected for investigation, four were subjected to phytotoxicity tests and three of them to field trials. These were, first, an oil in water emulsion containing 1% of pentachlorophenol; second, solid naphthalene; third, cashew nutshell oil. Neither of the first two materials showed any effect when applied to unattacked mature trees in heavily infested fields. The last named did not drive termites away from attacked young trees, though in the laboratory it exhibited a powerful repellent action. At this stage the search for a substance that would be repellent rather than poisonous was discontinued in view of satisfactory results obtained in tests described below.

Experiments on the protection of newly planted stumps, continued from last year, have given very promising results with the newer insecticides chlordane, aldrin and dieldrin, when emulsions were watered into the soil round the plants. The volume applied was 2 to 4 pints per point of emulsions containing 0.19%, 0.12%, 0.09% respectively of the three active ingredients. The minimum effective dosages have yet to be determined. Because of their effectiveness they have been tried for the treatment of attacked trees in immature rubber, with satisfactory results. Tests are now in hand in mature areas. While the quantity of solution being used is the same (up to two

pints) as when employing 1% mercuric chloride, at the dilutions in use the cost is only fractional. When the limiting effective dilution is known it may be possible to make still further economies.

OTHER INSECTS

Mites—The Laclaptid predator that is most important in the control of *Hemitarsonemus latus* (Annual Report of the Pathological Division for 1949, page 44) has been described as a new species (*Typhlodromus newsami*) by Mr G. O. Evans of the Department of Zoology, British Museum (Natural History).

Malformations associated with mealy bugs—Rearing *Planococcus citri* on potted seedlings in the air-conditioned glasshouse was continued from last year to observe the resulting malformations. On two plants the terminal shoot became deflected to a pronounced degree, in one case coming to lie horizontally. One shoot aborted; the other produced a flush of leaves showing some crinkling, but not the extreme form sometimes seen in the field. It is supposed that the less vigorous growth of plants in the glasshouse accounts for the differences. The malformations that have been produced experimentally correspond sufficiently closely to be regarded as confirming the suspected association of *P. citri* with a characteristic appearance of the growing shoots of young plants. The symptoms are, alone or combined, deflection of the growing point, crinkling of the basal part of the leaflet blade, thickening of the stem and close spacing of the leaf bases.

Oil emulsion sprays to control scale insects—The commonest method of destroying mealy bugs and scale insects is to spray with an oil emulsion such as can be made with kerosene and soap. Various proprietary materials are offered in which an oil is formulated so that it will emulsify spontaneously. Such materials are liable to deteriorate in storage. To make a kerosene/soap emulsion, on the other hand, requires labour, hot water and the use of a syringe.

An alternative and simpler solution that seemed possible was to mix kerosene with a locally available emulsifier that would give a spontaneous dispersion. By adding a critical amount of Lissapol N and water this does occur; the emulsion can then be diluted to the desired degree. However, disappointing results were obtained with kerosene-Lissapol N emulsions. A direct comparison between the two emulsions against *Saissetia nigra* and *Pulvinaria maxima* in a nursery showed that for some reason, perhaps over good wetting properties, the spray made with Lissapol N was quite inferior to that made with soap.

Control of ants—The same experimental area was used to try the effect of keeping the attendant ants (*Anoplolepis longipes*) away from the scale insects, to see whether they would then be killed by fungi or other parasites. By banding the stems with a tangle-foot preparation part of the nursery was kept free of ants for three weeks. Another part was kept free for five weeks by spraying once with 0.09% dieldrin emulsion. In neither area was any effect observed on the scale infestation.

OTHER ANIMAL PESTS

Deer repellent—Field tests with a proprietary deer repellent have given disappointing results. The need remains for a method of keeping deer from eating the bark of trees near the jungle's edge where fencing is not practicable. Preliminary bark burning tests with two materials that might be effective (a bitumen emulsion, and damar resin dissolved in petrol) has shown them both to be safe on young trees.

Nematodes—Eelworms attacking legume covers have been found in a nursery in the Institute compound. Injecting D-D, a soil fumigant widely used for eelworm control,

gave good results. It is apparent, however, that the method would not be economic on a plantation scale. The practical solution would be to plant covers that are not seriously affected. Susceptibility tests have therefore been started.

MISCELLANEOUS INVESTIGATIONS

Pollination of hevea—The publication of findings showing that insects pollinate hevea in Puerto Rico and Brazil led to observations being made here on the insect visitors to flowers. Flowering branches close to the ground have been kept under observation at various times of day. Small numbers of twentyone different insects were caught within or entering flowers. Many have been identified by the Commonwealth Institute of Entomology.

Spore trapping—It is important for many plant disease problems to study the dissemination of fungal spores. There are various ways of obtaining records of the spore content of air, and of collecting spores for identification. A hand operated vacuum spore trap has been fitted and tested in the field, as a preliminary to a detailed study of several practical problems. A continuously operating trap with an electrically driven pump has since been received and installed.

ROOT NODULE BACTERIA

Rhizobium strain for Flemingia congesta—The distribution by the Botanical Division of seed of *F. congesta* made a demand for a proved strain of *Rhizobium* to inoculate it. Culture 272, which has been widely distributed for the common creeping covers, does not succeed with *Flemingia*. Of several isolations made and tested, one (No. 419) has been found satisfactory. It has been distributed to a small extent only, as there is little seed of this new leguminous bush cover.

Pretreatment of legume seed—Various observations and tests have been made in collaboration with the Botanical Division on the pretreatment of legume cover crop seed. Acid or hot water treatment is advised to promote rapid germination. It should be followed by inoculation with a *Rhizobium* culture to ensure that an effective strain is present in the immediate vicinity of the young plants.

ADVISORY WORK

Root Diseases

There were three main subjects of enquiry: control measures in young rubber, preparing areas for replanting, and the identification of the parasites. The first was the principal theme. An interesting aspect of the problem that has come out of advisory visits is the transmission of white root disease (*Fomes lignosus*) to young rubber trees from legume creepers that have been allowed to grow freely round the trees. Infection starts at the collar, working downwards and outwards along the laterals. When the cover is pulled back, white fan-like growths of fungal mycelium may be seen spreading upwards from the collar under the mat of vegetation. *F. lignosus* mycelium will not spread into the open. Penetration and killing of the bark has been found to occur from collar infections of this sort. The observation shows that covers should be kept away from the trees in areas where white root disease is widespread.

A general article on root disease that was published in *Planters' Bulletin* 10 described how to identify the major diseases and discussed the other two subjects — preparing

for replanting and controlling root disease in young rubber — from an economic point of view.

Root disease due to a species of *Poria* has been encountered on an estate in Negri Sembilan. It was found to have started on the stumps of thinned out trees; from these it had in some cases spread to healthy four-year-old trees growing in the same holes. Only a few were killed though many carried superficial mycelium and some had one or two diseased lateral roots. The minor nature of the disease was evident. Two fructifications were produced in the laboratory on stumps which were kept watered for a month. One sent to the Forest Products Research Institute, Princes Risborough, enabled the fungus to be identified as *Poria hypobrunnea*.

Diseases of the Tapping Panel

Enquiries on the control of mouldy rot, which constitute most of the correspondence under this heading, have brought out little that is new. The fact that water miscible fungicides will bring the disease under control even under difficult conditions has again been demonstrated. In areas where the climate favours panel diseases it is the more necessary to keep undergrowth well slashed and to take prompt measures against new outbreaks. Some reinfection is inevitable after control has been achieved in an intensive campaign. It is when an outbreak is neglected, allowing it to build up during the next wet season into a heavy attack, that expenditure on control measures becomes so heavy.

A few estates reported panel infections that were found to be black stripe. In one case the disease was severe enough for control measures to be tried out experimentally, but it remains of infrequent occurrence and quite minor importance in the country generally.

Secondary Leaf Fall

The shedding of immature leaves following wintering is not severe enough in Malaya to call for control measures. *Oidium heveae*, which is the principal parasite, also attacks flowers, causing them to fall. An estate that is particularly concerned in the collection of valuable clonal seed may find it economic to dust with sulphur during the main flowering season, but other producers are not likely to do so.

The weather made for an unusual amount of late wintering all over the country. In most years the few reports received are from the south only. Recovery from wintering at the normal time was often slow, and passed into a second wintering. The fall of young infected leaf that occurred after this was due more to *Gloeosporium* than to *Oidium*.

Other Leaf Diseases

There have been the usual enquiries concerning bird's eye spot on young seedlings and *Gloeosporium* leaf disease on young buddings. Both diseases can be controlled to some extent by copper fungicides, but spraying is not generally called for except in nurseries where the density of the plants builds up a heavy infection. Other leaf diseases encountered included anthracnose, which is generally an indication of inadequate drainage, and a leaf spot caused by a parasitic alga, which is taken as an indication of poor conditions of growth. The algal parasite, *Cephaleuros mycoidea*, although sometimes producing conspicuous lesions, does little damage.

The weather must have particularly favoured *Gloeosporium* leaf disease, which brought about severe defoliation of trees three to seven years old at widely separated places. Refoliation of the bare but healthy shoots was sometimes long delayed. Clone PB 86 suffered more than others.

Stem and Branch Diseases

Leaf disease and consequent defoliation of young trees that have wintered and put on their new foliage has been seen in some places to have led to terminal dieback. Budded GI 1 and clonal seedlings have been affected in this way. The appearance corresponds with what was for many years called *Diplodia* dieback. Of late, however, the parasitism of this fungus on rubber has been doubted, though it invariably is found invading moribund woody tissues. Isolations made from specimens from many localities have repeatedly yielded one or both of two fungi — a species of *Colletotrichum* and a Sphaeropsid resembling *Phyllosticta ramicola*. Both have been recovered after inoculation into healthy young buddings, but they did not penetrate to any considerable distance. The *Colletotrichum*, however, in one case was found to have moved two inches. It appears that neither is more than a feeble parasite, able to advance only when the host tree is weakened in some way. Drought conditions intervening during a period of refoliation have been suggested as a possible cause.

A growing interest in pink disease is shown by the following numbers of enquiries received year by year: 1948 - 1; 1949 - 3; 1950 - 9; 1951 - 11; 1952 - 13; 1953 - 33. The trend can confidently be ascribed to the increasing acreage of young rubber, where alone the disease does noticeable damage, starting about the third year. The view that pink disease is better left alone is no longer widely held. The physical difficulties of pruning affected branches, and the unsuitability of hand operated sprayers for treating them from the ground, make it all the more desirable to stamp out the disease before it takes hold in a young plantation. Under certain climatic conditions the loss of the entire crown of the tree is not unusual if treatment is neglected.

Injuries of Non-Parasitic Origin

Two kinds of injury that are always liable to occur are from fire and lightning. An intense fire, as of sprayed and deadalang, may kill the bark right round the trunk to a height of two or three feet. In such an event there is no chance of saving the trees as no shoots will come away from the roots even though these are still healthy. With a light leaf fire the scorching is sometimes superficial and may be confined to one side of the tree. The need then is to scrape off the scorched bark before it attracts boring beetles, and to apply a protective dressing. With lightning damage there is nothing to be done except remove dead trees and prune those that are only partly affected. The difficulty here is recognition, as is shown by the number of enquiries in which a disease is suspected. The unvarying characteristics of lightning strike are, first, that several trees or many in a group are suddenly and extensively damaged — unlike the effect of a disease, which is progressive; second, that leaves turn brown and hang down from the branches. Other symptoms that may be seen are a sudden fall of green leaf, bleeding from the branches, strips of bark torn off, and discolouration of the cambium in regions where the outer bark is green. Trees that have escaped discovery for several weeks will be extensively invaded by boring beetles and saprophytic fungi.

Pests

Termites—The need for a cheaper treatment than mercuric chloride solution for immature rubber has long been felt and has been under investigation for several years. Tests put down towards the end of the year with insecticides that have recently become available have since given sufficiently promising results that their use can now be advised. They may also replace white arsenic for the treatment of mature trees.

Cockchafers—Only one outbreak of cockchafers was reported, from North Borneo. The grubs could not be identified from preserved specimens, nor could live specimens be introduced into Malaya for rearing. The attack was worst in nurseries and along river banks in field plantings, which were from belukar. Many hundreds of plants were destroyed, some as much as eighteen months old.

Other insects and mites—The usual types of attack have been reported — leaf injury and defoliation of young plants by mites and thrips; severing of the stems of young seedlings by crickets; caterpillars eating rubber leaves and natural covers; mealy bugs and scale insects of many species infesting the stems and leaves of young plants. Two unusual occurrences were reported. Caterpillars of a moth (a species of *Ptochoryctis*) were observed to feed on the outer bark of immature rubber trees on three separate plantations. Each caterpillar constructs a shelter under which it lives and feeds. The injury has been recorded before but is rarely encountered. Ants were reported to penetrate seeds set out in germination beds, to feed on the cotyledons. Specimens have been identified by the Commonwealth Institute of Entomology as *Pheidologeton affinis* Jerd.

Other animal pests—Confirmatory evidence of woodpeckers being responsible for bark injury, as suggested last year, was obtained from one estate. Slugs identified as *Parmation martensi* were found drinking latex from tapping panels and collecting cups. This curious behaviour also has been described before. More serious damage, though of sporadic occurrence, has been attributed to monkeys, deer, pigs and porcupines.

A protective dressing that has had good results claimed for it against a variety of pests of young rubber trees consists of a mixture of zinc phosphide and coconut oil. Because bark burning had sometimes been reported following its use, a series of tests was carried out with a range of mixtures applied to trees of various ages. It was found that there were some clonal differences in susceptibility to burning; that exposure to direct sunlight increased the chance of injury, but that the concentration of the poison in the oil had no effect on the result. Provided that the application was restricted to a thin smear it did not injure even the youngest plants. The method appears to be a useful one when carefully applied.

Distribution of Root Nodule Bacteria

Twelve hundred tubes of *Rhizobium* culture were distributed on request for the inoculation of legume cover crop seed.

Summary of Advisory Work and Correspondence

Letters despatched	1071
Specimens examined	450
Visits	171
Interviews	103

ARTHUR NEWSAM
Head of Pathological Division

Chemical Division

The graduate staff of the Division at the commencement of 1953 comprised Mr W. G. Wren (Head of Division), Mr G. W. Drake, Dr W. A. Southorn, Dr R. H. Smith, Mr L. L. Best, Mr H. M. Edmondson, Mr J. F. Morris, Mr A. S. Cook, Mr R. S. Gale, Mr K. C. Sekar, Mr Cheah Sein Liat, and Mr B. C. Sekhar.

Recruitments during the year were Mrs H. M. Overton, Microbiologist, on a temporary basis, Mr R. C. H. Hsia, Chemist, in January, Mr D. J. Graham, Chemical Engineer, in March, Mr P. F. Maher, Physicist, in June, and Mr S. J. Tata in December.

Dr R. Freeman, seconded from the British Rubber Producers' Research Association (B.R.P.R.A.), continued working in the laboratories throughout the year; Mr Cook returned from home leave in February and Mr Wren in October, Mr Drake having continued to act as Head of Division in the meantime; Mr B. C. Sekhar was awarded a scholarship tenable at the University of Michigan, U.S.A., and left on study leave in July; Mr Edmondson proceeded on home leave in August, and Dr Smith in October.

The Division continued to act as liaison between the Committee of Malayan Latex Technologists and the British Standards Institution Sub-Committee RUC/10/7 dealing with latex testing methods, although the volume of correspondence has become considerably less as the drafting of the new B.S. Specifications for latex approach their final form. Liaison has been maintained with Sub-Committee XII of the American Society for Testing Materials Committee D-11, which deals with raw rubber.

The Head of Division held technical discussions with staff members of the British Rubber Producers' Research Association (B.R.P.R.A.) at Welwyn, and of the London Advisory Committee for Rubber Research (L.A.C.) at the Imperial Institute, London. He attended meetings of the L.A.C. Technical Sub-Committee, in March, and of the Latex Sub-Committee, in June. Also, with a member of the staff, he attended the meetings of the International Rubber Research Board and the International Rubber Development Committee, held at Delft, Holland, during June.

Contributions to the *Journal of the Rubber Research Institute of Malaya*, published during the year, were:

'Determination of Volatile Fatty Acids in Natural Rubber Latex' (Communication 281) by M. W. Philpott and K. C. Sekar; 'Stability and Mineral Composition of Hevea Latex' (Communication 284) by M. W. Philpott and D. R. Westgarth; 'Factors Affecting the Measurement of Strain' (Communication 285) by L. L. Best; 'Fractions from Hevea Brasiliensis Latex Centrifuged at 59,000 g.' (Communication 286) by A. S. Cook and B. C. Sekar; 'Phosphatides of Hevea Latex' (Communication 287) by R. H. Smith. A contribution was made to the *India Rubber Journal*, entitled: 'Fungicides for Sheet Rubber' by A. S. Cook and K. C. Sekar.

The following articles were published in the *Planters' Bulletin*: 'Latex Anticoagulants,' 'Bare Back Baling of Sheet Rubber,' 'Identification of Water Based Bale Coatings,' and 'Air Dried Sheet'.

The account of work carried out by the Division which follows is divided into two sections. The first, headed 'Research', sets out in greater detail the research work carried out, and covers research designed to provide basic data not previously available, the application of basic data to specific projects and investigations arising from advisory enquiries. The second section, headed 'Advisory and Development' gives a brief résumé of advisory enquiries, indicates the results of research investigations which are of imme-

date interest to producers, summarises developments in special and modified rubbers which may be of commercial interest in the near future, and gives a progress account of Technical Classification of natural rubber.

RESEARCH

NON-RUBBER CONSTITUENTS OF LATEX

Microbiology

Although it is well known that micro-organisms readily infect and modify the behaviour of hevea latex, no systematic study has been made in Malaya on this subject since the work of CORBET (*Bull. Rubb. Inst. Malaya* 1 (1929)1) in 1929. During recent years efforts have been largely concerned with developing methods for cleaning and sterilising plant and for preserving latex and dry rubber against attack by bacteria and fungi. So far this work has been empirical in nature and although satisfactory results have been obtained, it will be agreed that many field and factory operations could be much improved by systematic investigation. Knowledge of the organisms present and of their behaviour would lead to better control of processing, both of latex and dry rubber. There is also the possibility that specific changes could be brought about in latex and in the dry rubber produced from it, by bacterial modification of non-rubber constituents.

Bearing these objectives in mind, preliminary investigations were undertaken at the end of 1952, to survey the microflora in field latex produced on Malayan estates. The technique employed consisted in preparing cultures of relatively pure strains of bacteria from samples of field latex, which, under the normal conditions obtaining on estates, is subject to contamination from tapping cuts, collecting cups, buckets and tanks, as well as from the atmosphere.

The first problem was to select a culture medium which would give optimal growth of the organisms and at the same time would be of a non-selective nature. The obvious choice was latex serum, provided it could be obtained in a sterile condition. For this purpose heat treatment was found to be impracticable as it caused flocculation above 70°C. It was found possible, however, to obtain satisfactory sterilisation by passing serum separated from latex by deep freezing through a bacteriological filter, and serum thus treated, together with agar, has been employed throughout the investigation as the culture medium for plating the organisms.

The first experiments were confined to samples of latex collected at fortnightly intervals over a period of three months from randomly selected trees growing at the Experiment Station, Sungei Buloh.

The more commonly occurring organisms isolated were members of the non-faecal coliform group mostly *Bacterium aerogenes*, and intermediate coliaerogenes organisms. A few representatives of the faecal coliforms have been isolated but only in occasional sample. *Zopfius zenkeri*, an organism closely related to *Proteus*, has been found in approximately half of the samples tested; it appears to be relatively inactive biochemically.

Members of the genera *Staphylococcus*, *Micrococcus*, *Flavobacterium* and *Chromobacterium* have also been isolated, mostly from latex before coagulation, and in

addition a few representatives of the aerobic spore-forming group. On serum agar plates where the bacterial growth was poor, representatives of the fungal genera *Penicillium*, *Fusarium*, and *Aspergillus* were observed.

Following on the preliminary investigations of samples of latex from the Experiment Station, a broader investigation was carried out using samples obtained throughout Malaya. Ten estates were selected over a wide area, ranging from Kedah to Johore, and samples taken from ten trees on each estate, the latex being transferred directly from the tapping cups into sterile bottles. All samples were found to be heavily contaminated, the non-faecal coliform group being predominant. *Zopfius zenkeri* and *Erwinia minipressuralis* were present in fair quantities, together with a few strains of *Staphylococcus*. Aerobic spore-formers were not abundant and appeared in only a few samples.

Various isolates of *Zopfius zenkeri* were studied and it was noticed that three different colony formations appeared. The organism was distinguished by a wide pH tolerance growing over the range pH 4.5—11.4 with an optimum at pH 6. Its growth was stimulated by quebrachitol but there was no demonstrable fermentation of the carbohydrate.

It is interesting to note that the present findings are generally in close agreement with observations made by earlier workers, both in Malaya and other countries.

An examination of the microflora present in ammoniated latex showed that ammonia at a level of 0.3 per cent inhibited the growth of coliform bacteria, but stimulated that of chromogenic forms and spore-formers. The chromogenic forms were found capable of surviving in the presence of 0.3 per cent ammonia for three to four days. Centrifuging removed approximately 80 per cent of the bacterial contaminants.

Enzymology

A study of the enzymes present in latex was undertaken as a necessary complement to the work on micro-organisms. In recent years this problem has been studied by our sister research institute, (I.N.I.R.O.), and our first approach has been to make a preliminary survey of enzymic systems, with a view to comparing Malayan findings with those of Indonesia. This work is not yet completed and the account given below is in the nature of an interim statement, which may be modified by later work.

A useful method of attacking the problem has been provided by the technique of high speed centrifugation described later in this Report. By this means latex can be separated into three fractions, an upper layer of cream, clear serum, and a lower layer of gel. Enzymic activity in the different fractions has been compared using the Warburg technique and the following types observed in latices collected under normal conditions at the Experiment Station.

Dehydrogenases were found to be strongly active in whole latex and in clear serum, but only slight activity was observed in the serum from the bottom fraction. No individual enzyme has yet been identified, owing to complications introduced by the presence of natural substrates and co-enzymes; it would appear that most of the enzymes require activation by a co-enzyme other than Co-enzyme I.

Enzymes capable of utilising mono- and polyphenols as substrates were found to be largely present in bottom fraction serum, in a highly active state. The oxidation was aerobic and appeared to require no co-enzyme. After removal of natural substrates by dialysis the enzymes remained active in oxidising phenolic substrates, but most of them were irreversibly inactivated by treatment with potassium cyanide followed by dialysis, which process also removed 90 per cent of the copper present.

Some polyphenol oxidases appeared to resist the cyanidedialysis treatment. No activity of phenol oxidase was observed in clear serum, owing to the presence of naturally occurring inhibitors.

Strong peroxidase activity was demonstrated in both clear serum and serum from the bottom fraction. The presence of catalase was not established in any latex fraction, which is contrary to findings in Indonesia. Slight ascorbic acid oxidase activity was shown in bottom fraction serum, the reaction being aerobic. No evidence was found indicating the presence of cytochrome reductase.

An enzymic-system has also been observed in the residue obtained after exhaustive extraction of the bottom fraction with water. This was not separable by a number of solvents tried, but was denatured by 0.05 N sodium hydroxide. The enzyme was found to act upon glucose, requiring activation by Co-enzyme I.

Another aerobically oxidative enzyme system was found to be present in clear serum, but it has not yet been identified.

Phosphatides

The presence of phosphatides in hevea latex was first definitely demonstrated by RHODES and BISHOP (*Quart. J. Rubb. Res. Inst. Malaya* 2 (1930) 125) in 1930, working at this Institute.

These substances are of interest for a number of reasons. They are surface active and may play a part in controlling the stability of latex. They contain fatty acids in a combined form, the liberation of which, from phosphatides or from other substances, is known to account in part, for the changes in ammoniated latex on storage. Phosphatides also contain phosphorus and may, under certain conditions, be expected to liberate phosphates, which again influence the stability of ammoniated latex. They are known to contain nitrogenous bases, which, as well as fatty acids, have a marked influence upon the vulcanising behaviour of dry rubber.

The object of the present investigation was to obtain the phosphatides of hevea latex in a fairly pure state, to identify and analyse them, and to study the changes which they undergo during the tapping and collection of latex, when it is coagulated, and during its preservation with ammonia.

Extraction and purification — The method used by previous workers for separating latex lipin was found to be unsuitable, as it obviously allowed changes to occur in the phosphatides during preparation. The method finally developed was to coagulate fresh latex in boiling alcohol, separate off the serum and evaporate to an aqueous residue. This was then extracted with petroleum ether, and water soluble impurities removed from the extracted lipin by dissolving it in a mixture of chloroform, ethanol and water, and passing the solution through a column of cellulose powder.

Composition — The major constituents of the purified lipid were determined by chromatographic analysis of hydrolysates. Chemical analysis of the lipid fractions, separated according to solubility in acetone and alcohol, permitted the following approximate composition to be calculated:

Lecithin containing combined reducing sugar	51 per cent
Metal phosphatide containing combined inositol and reducing sugar	10.5 per cent
Phosphatidyl ethanolamine	3 per cent
Triglycerides	20 per cent
Unsaponifiables	15.5 per cent

Choline liberating enzyme in latex — When fresh latex was coagulated with alcohol at 40°C or above, it was found that all the choline present was in a combined form. At lower temperatures, coagulation was immediately followed by liberation of choline in the free state. The breakdown leading to liberation of the choline was shown to be due to an enzyme, inactive in untreated latex, but rendered active on alcohol coagulation. The splitting off of choline from the lecithin molecule appeared to be the only change catalysed by the enzyme; phosphatidic acid was also liberated in the process, and then combined with metal ions to form salts. The enzyme was also activated by coagulating latex with formic acid at pH 4, and by freeze coagulation. Acid coagulation leads to the liberation of 95 per cent of the choline present within two hours.

On storing latex for a few hours before coagulation, it was found that the activity of the enzyme was reduced, although even after eight hours storage, nearly 60 per cent of the choline was still liberated within two hours after coagulation. Under the conditions normally obtaining in the factory, there is little likelihood of liberated choline being retained in the rubber, as in the free state it is readily water soluble and would be removed with the serum.

The effect of adding preservatives to latex has also been investigated and it was found that 0.7 per cent ammonia or 0.6 per cent formaldehyde rapidly destroyed the enzyme. With 0.2 per cent ammonia, the rate of destruction was much slower. In freshly prepared ammonia preserved latex, therefore, it appears that the phosphatide is present in an undegraded form. It was found however, that after standing for two weeks, less than 2 per cent of the phosphatide remained. The breakdown under these circumstances was quite different from that produced by the choline liberating enzyme, and it is unlikely that rubber prepared from ammoniated latex after two weeks storage will contain phosphatide (or presumably choline).

It is interesting to note that the maximum quantity of choline naturally occurring in rubber is about 0.15 per cent. At this level it has a marked activating effect upon the rate of vulcanisation of compounds containing one of the most popular accelerators, mercaptobenzthiazole. Methods of preparation likely to retain considerable proportions of free choline would undoubtedly lead to a fast vulcanising rubber.

The possibility of phosphatides being responsible for or involved in spontaneous coagulation was also considered. As the choline liberating enzyme is inactive in fresh latex, the possibility of phosphatide destruction from other causes was examined, using a number of latex samples from different sources. The amount of phosphatide present was between 0.5 and 0.8 per cent, and in some instances, a reduction in this value of 20 per cent was found after eight hours standing. In other latices, this breakdown was not observed, even though spontaneous coagulation occurred. It seems improbable therefore, that phosphatide breakdown is a factor which plays an important part in spontaneous coagulation.

CHEMISTRY AND TECHNOLOGY OF LATEX

Latex Fractions Separated by High Speed Centrifuging

In order to pursue our studies of the non-rubber constituents a method of separating clear serum from latex was essential; for this purpose high speed centrifuging was examined. The following observations were recorded in the course of the work.

Latex collected from our Experiment Station field of mixed clonal seedlings was spun at 20,000 r.p.m. to give 59,000 g, the temperature being maintained at 5°C. A further sample was ammoniated to 0.5 per cent and a part of it centrifuged at once, another part being first kept for twentyfour hours.

From fresh latex, four distinct fractions were obtained. The top portion was a thick cream of rubber particles in serum, containing 70-80 per cent solids; most of the material could be redispersed in water. This fraction was followed by a yellow orange layer, which when viewed under the microscope, was found to consist of spherical yellow particles, either single or in clusters. They appeared to be very similar to the well known Frey-Wyssling particles found in ammonia preserved latex. Beneath these two layers, the serum was clear, and slightly brown. It contained 7 per cent solids, which represented most of the protein, phosphorus, potassium, copper and ash contents of the whole latex.

The fourth fraction was a grey yellow gelatinous mass at the bottom of the tube. It contained 12 per cent solids. Under the microscope it was found to consist of a tightly packed mass of gel-like 'islands' similar to the lutoid 'islands' reported by our colleagues at I.N.I.R.O. This fraction contained most of the magnesium present in the latex. It contained 40 per cent alcohol soluble material, 30 per cent protein, 15 per cent rubber, and had an ash content of 17 per cent.

With ammoniated latex, four fractions were also observed, the upper three being similar to those shown by fresh latex, save that the serum layer was cloudy. The bottom fraction, however, was smaller and consisted of a white precipitate which microscopic examination showed to be formed almost entirely of star shaped crystals. The fractions obtained from ammoniated latex which had been kept for twentyfour hours were very similar.

Surface Area of Latex Particles

Further experimental work using the soap titration method developed by the B.R.P.R.A. for determining particle size of latex, has thrown considerable doubt upon earlier findings as the method has now been shown somewhat unreliable.

Measurements were found to be markedly temperature dependant in the range 20° - 30°C, and were influenced by the ammonia content of the latex; in general the higher the ammonia content the greater was the apparent surface area, although the data showed erratic variations.

Examination of latices from groups of clonal trees over a period of six months, showed marked month to month fluctuation, and earlier indications suggesting that latex from clone G1 1 contained particles having a relatively large surface area have not been confirmed.

It has been concluded that the soap titration method is not a reliable guide to particle size estimation for freshly ammoniated latex.

An alternative method has been considered which depends upon differences in the rate of creaming of particles having different diameters. If it is assumed that unhindered creaming takes place when a diluted latex is centrifuged, the minimum size of a particle creaming under specified conditions can be calculated. Measurement of the total solids content of the lower layer after centrifuging can then be used to determine the weight of latex particles below this size. Experimental work showed the method to be a practicable one and although great accuracy cannot be claimed, it may prove to be a useful tool when data on particle size distribution are required.

Short Term Preservation of Field Latex

Earlier investigations have shown that certain reagents are effective in preserving latex for a short time under neutral or slightly alkaline conditions. A more thorough investigation has now been carried out to determine the amounts of sodium sulphite, ammonia, and formaldehyde required to keep latex in good condition until 6 p.m. on

the day of tapping. As a check on good preservation, sheet was prepared from the latices by coagulation after 6 p.m. followed by sheeting next morning, drying and smoking in the usual way.

The minimum amount of preservative or anticoagulant required varied considerably with the condition of the latex. Wintering markedly affected the stability of the latex, but insufficient data were obtained during 1953 to state minimal quantities of preservative required. The following Table gives an indication of minimum quantities which were satisfactory under normal conditions at the Experiment Station, Sungai Buloh.

Preservative	Amount (per cent on latex)	
	Dry trees	Wet trees
Sodium sulphite	0.06 to 0.08	0.07 to 0.10
Ammonia	0.05 to 0.06	0.06 to 0.08
Formaldehyde	0.06 to 0.07	0.10
[Formaldehyde	0.02 to 0.05	0.04 to 0.06
[Sodium carbonate	0.05	0.05

Although the amounts of sodium sulphite recorded above were sufficient to keep latex in a good liquid condition, smoked sheet prepared from it usually contained fermentation bubbles. Increasing the amount of sulphate did not prevent this. The addition of small quantities of a bactericide to the sulphite latex, however, gave sheet free from bubbles. Sheet prepared with sulphite latex were lighter coloured than the control, prepared with no added preservatives.

Ammonia gave a more alkaline latex and extra acid was required for coagulation. The sheets were darker than the control.

Formaldehyde gave smaller, thicker and darker sheets.

The quantities of preservative given above were found to be adequate to preserve latex during transit by lorry over a distance of fifty miles. Experiments are in hand to determine the conditions for preserving latex for periods up to twentyfour hours after tapping.

Volatile Fatty Acid Content and Quality of Latex

The use of the volatile fatty acid content (V.F.A.) has continued to be of considerable service in assisting producers to improve the quality of latex concentrates. Although this development has not led to any different recommendations to estates, it has proved most valuable in indicating where good field or factory practice is not followed, and has permitted the establishment of better processing control. In a number of cases improved mechanical stability and lower KOH number of concentrates have resulted.

The rate of formation of volatile acids in ammoniated field latex is markedly delayed by ammonia, but proceeds at all concentrations up to 1.5 per cent on the aqueous phase (equivalent to 1 per cent ammonia on field latex at 35 per cent d.r.c.). Experiments show that a rapid increase in the rate of volatile acid formation occurs after a V.F.A. number of about 0.1 is reached. (V.F.A. number is the acid equivalent expressed as gm potassium hydroxide per 100 gm latex total solids). Delay in ammoniation and storage of the latex with an ammonia content of 1.5 per cent or less both increase the V.F.A. number.

The practice of mixing the ammoniated remains of the previous day's crop with freshly collected latex is to be avoided, as this keeps the general concentration of volatile acids high and the level of 0.1 where a rapid rate of increase occurs, is reached more quickly, with consequent ill effects on the quality of the concentrate.

An interesting observation records that the increase in mechanical stability which proceeds in latex concentrates during the first month or two after preparation, is most marked in latices containing small amounts of volatile acid; in cases where putrefaction has proceeded to give a high V.F.A. number, the increase in stability on storage is much less and in some cases does not occur.

Methods of estimation — The method of determining V.F.A. number, which employs steam distillation of the acids from latex serum, is cumbersome and alternative means are being sought. Meanwhile a modification of the existing method has reduced the time required to carry out a test from two hours to about half an hour. This has been made possible owing to a simple relationship which exists between the total volatile acids present (x) and the acid contained in the first 50 ml of distillate (y) condensed in the test procedure. It has been shown that for over a hundred latices tested, the following equation holds:

$$y = 1.43 + 9.18x$$

As an alternative means of determining putrefactive changes occurring in latex, a comparison was made between volatile acid content and specific electrical conductivity. Observations carried out on the changes occurring in ammoniated latex during storage, showed a significant linear relationship between the two quantities. It is doubtful, however, whether the same numerical relationship holds good for all latices, so that it appears unlikely that determination of specific conductivity can replace V.F.A. number as a guide to putrefactive changes. Where conditions are standardised, it may be satisfactory to use electrical conductivity as a routine means of checking throughput, but it is recommended that volatile acid determination is used as the final yardstick when putrefaction is suspected.

Mechanism of Latex Coagulation

Earlier attempts to produce dry rubber from fresh latex by a continuous method of coagulation showed two major difficulties. In the first place, fresh coagulum as normally prepared was too weak to be handled easily, and secondly, daily variations in the properties of latex collected in the usual way were marked, so that any standard process would have to tolerate wide divergencies in behaviour. It became apparent that further basic information about the factors affecting coagulation was essential before control could be effective and efficient plant designed for operating the process.

Preliminary experiments along these lines indicated that one of the most sensitive characteristics to study was the formation of a structure in latex, following the addition of a coagulant. Syneresis of the coagulum after formation was also investigated, but was found to be less tractable as a guide for indicating the changes proceeding. An apparatus was then constructed by means of which the development of structural rigidity in latex could be followed without removing the coagulum formed from its serum. This was achieved by measuring the resistance to small rotational movements of a vane placed in the acidified latex, the force required being indicated by a torsion head. The measurements were repeated at intervals so that a picture of the changes occurring with time was obtained. Trials with the apparatus showed the great importance of the age of latex before coagulation, upon the rate of structure build up.

An apparatus has now been constructed which is fully automatic and records the structure formation over periods of two or three days, or with much greater sensitivity, over periods of an hour or two. Experiments are now in hand to establish the factors which control rate of structure build up and the ultimate strength of the coagulum obtained.

CHEMISTRY & TECHNOLOGY OF DRY RUBBER

Molecular Characteristics of the Rubber Hydrocarbon

A convenient method for rapidly preparing solutions of rubber is to add latex directly to benzene, when the rubber dissolves, giving a solution which contains a little water. Such solutions are sometimes required to be dried before use, and in the course of finding a suitable means to do this, it was observed that the addition of a finely divided powder, such as calcium sulphate, reduced the concentration of the solution, as much as 15 to 20 per cent of the rubber being removed by the powder. It was also observed that this reduction in concentration had little or no effect upon the viscosity of the solution, thus indicating that the rubber removed by the powder was not contributing appreciably to the viscosity, and was thus not truly in solution, but rather in suspension. The material is thus similar in properties to that previously reported as 'microgel' rubber. It was also found that microgel can be removed from a solution of freshly tapped rubber by high speed centrifuging.

Microgel is found in freshly prepared smoked sheet. Samples of RSS 1 obtained from twentyfive different estates showed microgel contents ranging from 5 to 15 per cent. As far as could be ascertained, the microgel rubber was not appreciably affected by the processes of coagulation and drying in the smokehouse.

Microgel has not been detected in old smoked sheet, which normally contain insoluble rubber referred to as 'gel', or 'macrogel', to differentiate it from microgel. It appears that on standing the finely divided particles of microgel become linked together to form a coarse or macro structure of gel rubber, which is completely insoluble and does not pass into colloidal suspension as does microgel.

Microgel formation can be induced in latex by treatment with a redox system, such as peroxide amine; by such means as much as 40 per cent of the rubber can be obtained in the microgel form.

Attempts to estimate the size of the microgel particles as they occur in fresh latex, suggest that they have a diameter not greater than 0.1 micron. The amount of rubber in latex occurring as globules of this size, however, is insufficient to account for the amount of microgel usually present. It is considered possible, therefore, that the microgel particles occur not only as separate latex globules but also as parts of larger globules. This suggestion is supported by the fact that if latex is separated into large and small globules by centrifuging, the rubber from the small size globules contains less microgel than that from the large ones.

It should be pointed out, that the presence of microgel increases the uncertainty of molecular weight measurements of rubber hydrocarbon from fresh latex. In viscosity determinations, it acts as an inert diluent, the true concentration of the rubber in solution probably being some 20 per cent less than that calculated from dry weight of rubber and volume of solvent. In osmotic pressure determinations microgel blocks the membranes, making them impermeable to solvent. In light scattering measurements, the scattered light is due largely to the presence of microgel particles and not to dissolved rubber. It is thus imperative that in any work assessing the molecular character of rubber from fresh latex, all microgel is eliminated before measurements are made.

Preparation of Rubber from Skim Latex

The disposal of latex skim from concentrating processes is a problem which has not yet been solved satisfactorily. Although rubber in the form of sheet or crepe can be prepared by coagulation of the skim, its properties are inferior and it is barred from inclusion in any consignment conforming to R.M.A. types, by the Specifications issued in New York.

Skim rubber prepared by direct coagulation contains less than 85 per cent rubber hydrocarbon, compared with 93—94 per cent in smoked sheet. It is a scorchy rubber and is difficult to deal with in manufacturing rubber goods. Recent tests carried out in our laboratories have shown some skim rubbers to contain high amounts of copper, up to 40 p.p.m., which is a dangerous contaminant as it leads to poor ageing both of the raw rubber and of vulcanisates prepared with it.

Work has been initiated to investigate methods of preparing a better quality rubber from skim latex. The process used is one which was first studied by the Division in 1933, and employs destruction of proteins by enzymic digestion. By this means rubber containing a higher proportion of hydrocarbon is prepared, as much as 90 per cent being readily obtainable, provided the digestion is carried out under optimum conditions of pH and temperature. Control of the pH is also important for reducing to a minimum the copper content of the final rubber. Addition to the skim latex of calcium ions at low concentrations has also been found very effective in reducing the copper content of the product; by this means the amount can be reduced to below 8 p.p.m., the maximum stipulated by the R.M.A. New York specification for normal market grades. Further work is being carried out with a view to applying these findings to commercial production.

Testing Methods

Dirt content—In view of the increased interest in the cleanliness of raw rubber shown particularly by American consumers, attention has been given to methods of assessing the dirt present in commercial samples.

Three ways of measuring the dirt content of RSS 1 were investigated: (a), the total ash was determined by a dry ashing method, (b), total insoluble material by solution in a suitable solvent, followed by filtering, and (c), insoluble material by solution and sieving through a 325 mesh A.S.T.M. screen.

Ash content was found to bear no simple relationship to dirt content, so was not investigated further. Determination of the total insoluble material was unreliable, as the results were not reproducible. The third method gave reproducible results in our laboratory and has been employed for later investigations. The method is, however, not easily standardised and an interlaboratory trial organised by I.N.I.R.O. showed widely divergent results between individual laboratories. The technique has yet to be more closely defined before the method can be adopted as standard.

Using this method, determinations carried out with R.M.A. grades have shown considerable differences between the types as produced in Malaya. Tentative values are as follows:

RSS 1	..	..	..	0.025	per cent
RSS 3	..	..	..	0.09	per cent
Pale crepe	..	..	..	0.020	per cent
Remilled crepe	..	..	..	0.2	per cent

These values await confirmation by a more extensive survey of Malayan production, which will be undertaken when an internationally agreed method of estimation has been established.

Rapid strain test for vulcanised rubber—For test procedures on vulcanisation characteristics, most National Standards recommend a delay of at least one day between each of the three processing stages involved, mixing, vulcanising, and testing. It will be appreciated that these delays require a period of at least two days for completion of the test. This condition has proved a serious obstacle in classifying certain types of natural rubber, where a rapid throughput is required.

It was already known that tests carried out by omitting the periods of conditioning for compounded stock and for test pieces give results different from those obtained by following the standard procedure. There was, however, no reason to suppose that a simple relationship should not exist between the data obtained from the two methods. This has been confirmed experimentally, and a simple relationship has been established for test pieces vulcanised according to the A.C.S. number 1 formulation and cured for forty minutes at 140°C. If S_n and S_r are the strain values given by the normal method and the rapid method, under the conditions employed,

$$S_n = 13.15 + 0.775 S_r$$

In the rapid method, the compound is vulcanised in the usual way as soon as mixing is completed. After removal from the moulds, the test pieces are immersed in cold water for ten minutes, dried and tested as soon as possible. There is some evidence to indicate that a reduction in test error is achieved by using the rapid method of test.

Hardness test as a method of classifying rubber—It has been suggested by our colleagues at the L.A.C. that the measurement of hardness, as for instance by means of the Wallace deadload hardness gauge, might be a simpler method than the strain test for classifying natural rubber on the basis of vulcanisation characteristics.

A brief experimental investigation showed that linear equations could be derived relating B.S. hardness with modulus at 660 per cent elongation and relating log B.S. hardness with strain. The method thus appears workable, but is not recommended in preference to strain determination, as the discrimination given between different rubbers was found to be less. The tests require about the same length of time for operation.

Accuracy of strain testing—In any scheme involving tests which have to be carried out in different laboratories, it is essential to employ test methods which can readily be standardised. During the year, attempts have been made to improve the accuracy of the strain test, which is used internationally for classifying rubber.

Experiments have shown that more uniform test pieces are obtained by reducing the weight of the blank used in moulding, the loading previously recommended being excessive. Previous recommendations to correct strain values with respect to the Mooney viscosity of the unvulcanised stock, have also been found to require modification, as in the case of remilled rubbers such corrections have been found unnecessary.

Several experiments have indicated that from some points of view a low elongation modulus test is more readily standardised than the strain test at present employed. Correction of data for variations in cross sectional area is far simpler in the case of modulus determinations. A further advantage is that slippage of test pieces in the jaws of the test machine can easily be compensated when constant elongation modulus is determined, whereas correction for strain measurements is considerably more complicated.

SPECIAL PURPOSE & MODIFIED RUBBERS

The progress made by special purpose synthetic elastomers, has shown the importance of producing materials from natural rubber for use in specific fields, if the market for natural rubber is to be maintained. A number of materials having improved specific properties have been investigated during the year, of which the following are the most promising.

Bleached Crepe

The chemical bleaching process developed in the Division for destroying the yellow colouring matter in latex has continued to be used quite extensively and further experimental work has been carried out largely as a result of enquiries made by manufacturers of pale crepe.

The amount of daylight falling upon the crepe during drying has been found to be an important factor in controlling the colour finally obtained. Diffuse light catalyses the bleaching reaction, permitting the use of smaller amounts of the bleaching agent. Excessive amounts of light caused a brown discoloration to develop. In general our experience indicated that a somewhat darkened drying shed is to be preferred. It is difficult to recommend any specific type of lighting as the optimum amount varies with the source of the latex, some latices being much less susceptible to discoloration than others.

It has also been shown that, where the minimum amount of the reagent required for bleaching has been exceeded, a grey discoloration of the crepe sometimes results.

Purified Crepe

Interest has been shown by consumers in the U.K. in partly purified crepe rubber. This was prepared with centrifuged latex concentrate by coagulating at a d.r.c. of 5 per cent.

Hardened Crepe

Hardened crepe rubber, having a Mooney viscosity of 150 or more, has been prepared by treating latex in the cold with redox systems, similar to those employed in synthetic polymerisation processes. This material is considerably harder than the sole crepe of commerce and trials are in hand to test its suitability for shoe soling and other applications.

Rubber with Special Processing Properties

Manufacturers in the U.K. have shown considerable interest in samples of rubber having special processing properties, which has been developed in the Division. The material is prepared by mixing a partially vulcanised latex with field latex to give a dry rubber containing twenty per cent of the lightly vulcanised material. The rubber is of particular value in operations involving extrusion processes. Application for a patent to cover the process has been made.

Cyclised Rubber

Studies of cyclisation conditions, particularly in regard to temperature and acid concentration, have led to a considerable reduction in the cost of preparation, without, as far as can be ascertained, any reduction in quality. It has also been established that better yields can be obtained by preparing masterbatches with higher proportions of raw to cyclised rubber.

Experiments using skim latex to prepare the masterbatch showed that satisfactory material could be prepared. Yields were more variable than those obtained with field latex, and means to control the variability require further study.

Rubber Lignin Masterbatches

Reports received from the U.K. on samples of rubber lignin masterbatch prepared in Malaya have been encouraging. The materials possess outstanding resilience and good resistance to tear, properties which should be of considerable value in a number of commercial products. A further batch of material, about 400 lb, was sent for evaluation by manufacturers towards the end of the year.

Air Dried Sheet

Although air dried sheet is not strictly speaking a new development, considerable interest has recently been shown by the market in this form of rubber, which is of value in manufacturing goods having light colours. One of the difficulties experienced in producing air dried sheet is variation in colour, some sheets developing a dark hue, due probably to enzymic activity.

It was found that both ammonia and formaldehyde added as anticoagulants slightly darkened the sheet, whereas the addition of sodium bisulphite to the latex gave a pale coloured sheet, but increased bubble formation. A combination of formaldehyde added to the latex together with flooding of the coagulating tank with sodium bisulphite, gave rise to an even paler sheet; bubble formation was also reduced by this treatment.

A process for producing sheet with an improved pale colour cannot yet be recommended, as the reliability of the above treatments has yet to be established.

FACTORY PRACTICE

Line Ahead Creping Battery

Parts I and II of the line ahead creping battery were finally assembled in working order and trials with the complete unit carried out towards the end of the year. The following conclusions were drawn:

- 1 The use of a scrap washer and building up rolls shows no advantage over the conventional macerator, either in power consumption, capital cost, or output.
- 2 The finishing machine, in which five pairs of lightly constructed rolls are arranged line ahead, was found to be insufficiently strong to enable a fine crepe to be produced. The remedy is either to increase the strength of the rolls to make them comparable with those of a conventional battery, or to use a much larger number of lightly constructed rolls. Thus there would be little or no reduction in capital cost or power consumption.

No further investigations along these lines are envisaged at present.

Variability in Estate Rubber

Variability in estate rubber can arise from many different sources, and the object of the present investigation was to assess the effect of certain factory operations upon the vulcanising properties of R.S.S.

In a statistically planned experiment covering a period of six months, routine operations in the Experiment Station factory were controlled to permit a study of the three following factors:

- 1 Bulking of latex collection vs direct reception into coagulating tanks.
- 2 Normal control vs rigid control, in respect of the following conditions:
Latex dilution, acid addition, mixing of acid and latex, dripping time, time in smokehouse and temperature of smokehouse.
- 3 Preparation of bales so that each had an equal number of sheets from each coagulation tank vs no special segregation of sheets.

The experiment was carried out on latex from defined areas of the R.R.I. Experiment Station, so that the latex supply was subject only to adventitious variation due to weather, seasonal fluctuations and so on.

Tests were carried out on bales which were sampled and tested according to the procedure used for Technical Classification of rubber. On this basis, it was found that of the three factors enumerated above, only the introduction of a blended packing procedure had any significant effect in reducing between bale variability. This result should not be taken to indicate that in estate factories the other variables considered above are unimportant. Individual investigation of each factory would be required to establish such a point. The experiment serves to show, however, that in a factory where processing is reasonably well controlled, significant improvement in variability may be achieved by adopting a blending packing procedure.

ADVISORY AND DEVELOPMENT

The volume of general advisory work carried out by the Division has remained at much the same level as in previous years. Office records, show the following:

Interviews at Headquarters and E.S. Factory	482
Visits by Officers	356
Letters & Reports:	2,881
Sheet rubber production	503
Crepe rubber production	502
Latex production	631
Other rubber products	241
Technical Classification of Rubber	1,004
Samples examined (excluding those examined in connection with technical classification)	2,161
Lectures to Planters' Associations	9

Enquiries received were mainly concerned with the following subjects:

Dry rubber content of field latex; Latex processing, quality and testing; Defects in sheet rubber, mainly due to pre-coagulation; Production, bleaching and defects of crepe; Design and defects of smoke-houses; Methods of producing dry rubber from skim latex; Powders for bale coatings.

Investigations arising from advisory enquiries have been concerned largely with latex. A fairly comprehensive study of anticoagulants, or short term preservatives, has been continued and has provided useful information in regard to reagents suitable for preserving field latex in a good fluid state until 6 p.m. on the day of collection. The preservatives were also effective in keeping the latex in good condition during transport

by lorry over a distance of fifty miles. Further study of the volatile fatty acids (V.F.A.) formed when putrefaction occurs in latex, has led to a marked improvement in the quality of latex concentrates produced in a number of factories. The practice of mixing incoming field latex with the remains of the previous day's crop, has been shown to have a deleterious effect upon the quality of latex concentrate. A method of preparing dry rubber from skim latex has been investigated, which promises to give a rubber having reasonably good technical properties. The problems usually associated with skim rubber, viz. low rubber hydrocarbon content and high copper contamination, have been satisfactorily overcome. Although laboratory investigations are now more or less completed, a considerable volume of work still remains to be done in applying findings at bench level to commercial scale operations.

The R.R.I. process for producing bleached crepe is now well established, but further investigations have shown that by attention to certain details of processing, a more satisfactory material may be obtained.

During the year a number of new rubber products were further investigated, some of which may ultimately prove to be of industrial value, and require production in Malaya on a commercial scale. Interest has been shown by consumers in the U.K. in a partially purified crepe rubber prepared from latex concentrate and also in rubber with easy processing characteristics, prepared by incorporating vulcanised latex into field latex prior to coagulation.

Improvements in the method of preparing cyclised rubber have resulted in reducing cost of production. Demonstrations and advice have been given to many interested producers, and commercial production on a small scale using the modified process was under way at the close of the year.

Reports from the U.K. on rubber lignin masterbatches prepared at the R.R.I. have been encouraging and manufacturers' opinions are now being sought.

Some interesting observations on the production of air dried sheet have led to improved colour but no specific process for producing a paler sheet can yet be recommended.

Technical Classification of Natural Rubber

The scheme for classifying natural rubber on the basis of its technical properties has continued to operate in the major producing countries under the auspices of the I.R.R.B. During the year, the R.R.I. was asked to take over coordination of the work on production and testing carried out in the different producing territories. Although this arrangement did not come into full operation until 1 January, 1954, a considerable amount of coordination work was carried out during 1953.

Following upon surveys of Malayan smallholder's sheet packed in godowns, it became apparent that the distribution of technical properties of this rubber was different from that of estate sheet; as a consequence difficulties were experienced with many consignments falling on the border line between two classes. A modification in the classification scheme to meet the wider requirements was therefore proposed by the R.R.I. After some amendments, the proposed scheme was approved internationally and the date for its adoption agreed as 1 January, 1954. Although the new scheme does not change the existing class limits, it permits tighter control of the classes and reduces the possibility of misclassification.

During the year experimental work was undertaken in the laboratories with a view to improving the test methods used in technical classification. An account of the work is given in the first part of this Report.

The classification of Malayan produced rubber has been continued at the R.R.I. testing station, and in view of the increase in production during the year, plans for equipping another testing laboratory were put in hand with a view to doubling the existing testing capacity. The new station is expected to become ready for service early in 1954.

In respect of estate rubber, the main emphasis has been on improving the control of preparation on estates, and on increasing production. As described on page 72 of this Report, large scale experiments indicated that bales with greater technical uniformity could be produced on an estate by the use of systematic scrambling of sheet before packing. A number of large estates are now blending sheet before packing, and have achieved considerable success in reducing variability.

The rate of production of T.C.R. in Malaya increased considerably during the year, the total quantity exported being 10,250 tons during the first half year and 16,200 tons during the second half. The rubber consisted mainly of R.M.A. types RSS IX and RSS 1.

Technical classification of rubber packed in godowns has expanded rather more slowly than was hoped; about 1,400 tons was exported in 1953. The problems associated with classifying packing house rubber have been largely overcome and new techniques for selecting and blending sheets prior to packing have been used successfully in some godowns. All Malayan packers approached so far, have agreed that the procedure for technical classification of their production involves comparatively little trouble for the organisation.

The relatively slow development of technical classification for lower grade sheet is due to the fact that extra handling, storage, and a slight reduction in throughput involves a small additional cost in packing, which is sufficient to limit the number of organisations willing to undertake classification. The main bulk of present production is sold by direct negotiation between packer and consumer. It is hoped that considerably larger quantities of technically classified lower grades will be available through normal market channels during 1954.

The first consignments of technically classified remilled rubber were made from a Malayan estate in the first half of 1953. Later in the year, further quantities were shipped from a remilling factory. It has proved possible by a little re-organisation of factory procedure, to produce consignments of remilled rubber showing remarkable technical uniformity. In general, however, expansion of the output of technically classified remilled rubber is being hindered by the same difficulties as mentioned for lower grade sheet.

W. G. WREN
Head of Chemical Division

Smallholders' Advisory Service

Mr J. M. F. Greenwood was absent on long leave from 16 February till 10 November. Mr J. W. L. Bevan was seconded for full time service with the Joint Working Party from the beginning of September up to the end of the year. Mr L. R. Davidson was on duty throughout the year.

The high incidence of leave and secondment of senior staff prevented any increase in field visits with Rubber Instructors. Administrative work at headquarters was increased by staff postings and incidental arrangements to assist the Rubber Industry (Replanting) Board in initiating the Replanting Scheme for smallholders. The operation of this Scheme, and development work on the processing problems of smallholders, increase the need for a sound technical advisory service for rubber smallholders. Attention has been given to improvements which may be possible in the face of a shortage of technically qualified personnel.

From May onwards the three Superintendent Rubber Instructors were seconded to the R. I. (R.) B. to act as Assistant State Replanting Officers. In view of the notable reduction in the strength of the Smallholders' Advisory Service consequent upon assistance provided for the R. I. (R.) B. no provision was made for replacing the seconded Superintendent Rubber Instructors.

Seven of the most senior Rubber Instructors were seconded for service in the Replanting Scheme during March, April and May and continued to serve the R. I. (R.) B. on secondment for the rest of the year. Twelve transfers of station were arranged including seven to meet the direct needs of the R. I. (R.) B. Eleven Rubber Instructors were on long leave for varying periods resulting in a loss of 27 Instructor months.

Mr Chen Chen Chuan and Mr Chin Kai Ming were appointed Rubber Instructors on 1 May having completed the diploma of the College of Agriculture. After a period of training and initiation in general duties they were posted to their first stations in October.

All Rubber Instructors engaged in R.R.I. duties attended a meeting in Kuala Lumpur from 23 November to 28 November when matters of general interest were discussed.

In July the Board approved a cadre of ten Junior Rubber Instructors on a salary scale between those of Rubber Instructors and Rubber Demonstrators. The aim is to permit the recruitment and training of young men with a higher standard of general education than have generally been attracted to the post of Rubber Demonstrator. These new appointments will help offset the loss of Rubber Instructors to the R. I. (R.) B. and to Government Departments.

One Rubber Demonstrator was promoted Junior Rubber Instructor in August. During December candidates for appointment were interviewed in all parts of the country for selection for a training course for prospective Junior Rubber Instructors to be held early in 1954.

Our policy during the year was to release Rubber Demonstrators to the Replanting Scheme as required by the R. I. (R.) B. and to replace these men only when they were required for work on subjects other than replanting. It is considered that Rubber Demonstrators have a particular value in the remote areas of Pahang and the East coast states when land is being opened for new planting in relatively large blocks. Such areas are frequently not easily accessible and Rubber Instructors' visits are not sufficiently frequent at critical seasons to secure application of methods advised.

Thirtyone Rubber Demonstrators left the service during the year. Of these twenty-six were known to have obtained appointment with the R. I. (R.) B. either as Replanting Subordinates or Replanting Assistants. Only seven new Rubber Demonstrators were appointed and the total number in the service at the end of the year was therefore thirty.

Training—During the Easter vacation special duty was planned for the six R.R.I. scholarship holders at the College of Agriculture. This aimed at giving the prospective Rubber Instructors early experience of living and working in rural areas and in observation and recording of data. Under Mr Bevan's direction investigations into smallholders' production techniques were carried out in relatively limited areas of smallholdings. With volunteers from amongst other students at the College two teams each of four investigators were located in smallholding areas in Segambut and Ulu Langat during three weeks following a week of instruction at the R.R.I. Experiment Station.

Similar initial training was arranged for the two new Rubber Instructors appointed in May. Following a fortnight's study at the R.R.I. Experiment Station they undertook investigations in the Mukim of Ijok during a period of six weeks. They then spent two months on the R.R.I. Experiment Station prior to assisting in the identification of the sample holdings for a projected survey at Grisek. This work occupied a further period of five weeks.

A special course of training was conducted at the R.R.I. Experiment Station for prospective Replanting Assistants from 6 July to 19 September. Thirtyfour nominees of State Replanting Officers attended this course. In addition to demonstration and practice in field work lectures were given by senior officers. The general education level of the trainees was lower than had been expected and this limited the instruction that could be provided. Instructions and lectures by senior officers were repeated in Malay by 'Che Osman bin Ismail who was stationed at the Experiment Station to take charge of the course. The course included a brief sequence of training in elementary surveying provided by the Technical College. During the final stages of the course instruction in their special requirements were provided by officers of the Replanting Scheme.

The annual intensive course on rubber for students of the College of Agriculture was held at the R.R.I. Experiment Station from 29 September to 10 October. The course was supervised by Mr Wong Mun Yun and Mr Cheah Kwok Choy and twentyfour students accompanied by a member of the staff of the College of Agriculture attended.

A short intensive course for 30 Malay speaking nominees of State Replanting Officers was held from 30 November to 23 December and supervised by Tuan Syed Mamdooh Wafa.

Four young Malay speaking members of the staff of the Department of Agriculture, Brunei, were sent to the Rubber Research Institute for a three month period of training at the beginning of October. They were given the opportunity to study practical techniques required in rubber growing and processing under the care of a Malay member of the staff of the Experiment Station. They received instruction by films, lectures and demonstrations provided for the courses for the Agricultural College students and for Replanting Subordinates. They were also stationed for a period of a week with a Rubber Instructor to obtain experience of extension work and practical conditions and developments on rubber smallholdings in this country.

Accommodation for Rubber Instructors—Funds have been provided for building quarters for Rubber Instructors in selected stations. Steps have been taken to acquire

land in ten stations and in two cases applications have been approved and survey and alienation fees paid.

Officers at headquarters have taken part as required in consultations with the Executive Officer, Fund B, of the R. I. (R.) B. and his officers on the Replanting Scheme for smallholders, particularly in relation to technical requirements and experience gained by the Smallholders' Advisory Service in working amongst rubber smallholders. Throughout the year the attention of field staff was devoted primarily to replanting. Rubber Instructors assisted by publicising the Scheme amongst smallholders and explaining the detailed requirements. They also helped to train subordinate staff for the Scheme and introduced them to their areas of operation.

Our assistance to the Department of Agriculture in the provision of planting material for smallholders continued. This took the form of investigating sources of supply of good clonal seeds and assisting in the organisation of collection and distribution of seeds. Budwood for smallholders was at all times available on the smallholders nursery at the R.R.I. Experiment Station under the control of the Manager.

Plans for Mr Bevan to assist R.I.D.A. in undertaking a production survey of rubber smallholdings in the Mukim of Grisek, Johore, were abandoned after considerable preliminary work had been undertaken. This project had to give place to a more important requirement.

Assistance on technical questions was required by a committee appointed to inquire into the working of the Rubber Excise (Penang) Ordinance 1949. Mr Davidson undertook a tour of visits to smallholdings on Penang Island during three days in August and submitted a report on production levels observed.

Officers at headquarters were involved in early discussions with the Joint Working Party of the rubber industry and government which was constituted to accumulate data for a projected mission on the rubber industry. Mr Bevan being well qualified to assist the Statistician in the planning and execution of pilot surveys of rubber holdings was seconded for service with the Joint Working Party for a period of eight months from September 1953. It was decided that Rubber Instructors should be made available when required to record data in a pilot survey of medium holdings (area 25 acres to 100 acres). Advantage was therefore taken of a meeting of Rubber Instructors in Kuala Lumpur to instruct them in the use of a questionnaire, to test this in the field and make modifications suggested by practical experience.

A D V I S O R Y

Manufacture

As a result of priority given to work on replanting on smallholdings and assistance to the R. I. (R.) B. efforts to secure improved processing on smallholdings had to be relaxed. After the end of April we abandoned attempts to record quantities of smallholders' rubber being submitted to central processing. It is intended that this concentration on one particular problem of smallholders should be temporary and that manufacture shall receive proper attention in 1954.

Quantities of smallholding rubber recorded by Rubber Instructors as collected for sale as latex or processed in small central factories for the period January to April are set out as follows:

<i>Territory</i>	<i>Latex (tons)</i>	<i>Sheet rubber (tons)</i>
Selangor	308	47
Negri Sembilan	302	4
Malacca	—	18
Perak	19	15
Johore	790	168
Pahang	13	14
Kedah/Perlis	156	31
<i>Total</i>	<u>1,588</u>	<u>297</u>

These figures show that the increased demand for latex from smallholders noted in the last quarter of 1952 was maintained in the early part of the year. Later there were indications of a reduction in collection of smallholders' latex for concentration but no figures are available.

A notable event in the field of manufacture was the success of the Cooperative Societies Department in securing the establishment of a society for the central processing of smallholders' rubber in the Ulu Langat valley. This society now operates by collecting smallholders' latex at a series of collecting points and selling to a producer of latex concentrate. It is, however, in a position to establish a factory for production of sheet rubber should the outlet for liquid latex fail.

Rubber Planting

Replanting reported by the Replanting Scheme exceeds 20,000 acres for 1953 and from acreages reported as under direct observation of Rubber Instructors we have been assisting little more than half of this total. Since the Replanting Scheme is the obvious source of statistics on smallholders' replanting we have relieved Rubber Instructors of the task of recording acreages of replanting in their districts. In view of the large acreages likely to be replanted in the future the best chance of assisting with our reduced staff lies in close collaboration with the Replanting Scheme at all levels and endeavouring thereby to secure the application of sound methods by smallholders.

The Replanting Scheme, by control of finance, can powerfully influence the smallholder in maintaining his holding satisfactorily during the first two years, in applying suitable fertilisers and in establishing high yielding material either in the form of clonal seedlings or by budgrafting. From the end of the second year the inducement to proper maintenance may be inadequate for the less energetic smallholders because the grant instalments from this stage onward are little more than sufficient to meet fertiliser requirements on average inland soils.

The three main difficulties which face the smallholder in the early stages of replanting are disposal of the old stand, protection of his young trees from the depredations of animals and the control of *lalang*. Felling and burning old rubber trees is a laborious undertaking and without special treatment of the stumps, results in increased risk of root disease infection for the young stand. It is hoped that trials being carried out at the Rubber Research Institute in the use of 2,4,5-T as a tree poison will result in a satisfactory and economic method for smallholders to dispose of their old rubber trees.

The treatment of *lalang* is likely to be a more difficult subject on which to provide acceptable advice for smallholders. Experience on large estates does not suggest that

a method of treatment can be developed with present known herbicides which would be likely to be effectively applied on the majority of smallholdings. In the circumstances the best advice which can be given is to dig out lalang and use the cultivations necessary for this purpose for the production of profitable inter-crops.

Damage done by animals to young rubber plants on smallholdings can effectively prevent the establishment of a satisfactory rubber stand in certain areas. In replantings as distinct from new plantings the damage is generally done by domestic animals. In view of the high cost of fencing small isolated replantings it might be well worth considering provision of properly fenced communal grazing areas for villages. Such areas could provide superior grazing and improved livestock management.

Acreages of new planting recorded by Rubber Instructors in 1953 are noted in Table 1.

TABLE 1: SMALLHOLDERS' NEW PLANTING

Territory	Acres
Negri Sembilan	499
Perak	723
Johore	235
Pahang	2,580
Kedah/Perlis	922
Kelantan	805
Trengganu	575
<i>Total</i>	6,339

No new planting is recorded in Selangor, Malacca or Penang and Province Wellesley and it is believed that no new planting will be allowed in these territories while replanting is receiving attention on a large scale. Planting on new land in Johore shows a considerable reduction on previous years and it is evident that the major acreage of new planting for several years to come will be in Pahang, Kelantan and Trengganu. Poor communications in these states exaggerate the difficulties of bringing technical assistance to planters and considerable obstacles have to be overcome if such plantings are to be of full economic value to the country. The claim of these areas for planting material equal to that available for replantings needs emphasis.

Planting Material

Assistance from C.D.&W. funds for the provision of planting material was terminated at the end of March but the detailed arrangements developed in previous years for production of supplies were maintained unaltered. The Department of Agriculture secured the necessary finance for this work from the R. I. (R.) B.

The Rubber Research Institute continued to undertake the greater part of the work connected with the collection and distribution of clonal seeds. This included arrangements for the collection of seed from estates in Selangor which produced approximately 60 per cent of the total supply. The work of demarcating possible new areas and supervising trial collections necessary for the investigation of new sources was undertaken by Rubber Instructors who, in the absence of other arrangements, generally continued to be responsible for further collections from approved areas and for forwarding seed supplies. Examination of all seeds from new sources was carried

out at the Rubber Research Institute up to the time when an area could be approved or a decision given to discontinue collections. The allocation of all seeds surplus to the needs of the territory in which they were produced was arranged at the Rubber Research Institute. In this we followed a policy agreed with the Chief Field Officer of the Department of Agriculture.

The short seeding season in January, February and March was the most satisfactory we have experienced. Nearly two million seeds were obtained compared with less than three quarters of a million at the same period in any previous year. The greater part of this increase was the result of good seed fall, less than 25 per cent of the total coming from new sources. The main seeding season commenced at the end of July and reached a peak at the beginning of September. It was again an exceptionally good season with supplies continuing to the end of the year.

The value of large supplies of clonal seed for smallholders' replanting was appreciated by the R. I. (R.) B. and their officers and Agricultural Officers were asked to endeavour to secure new sources of supply through personal contact with planters. Information on known potential sources was made available from the Rubber Research Institute. As a result of these efforts certain new sources were brought into the scheme in Pahang, Malacca, Negri Sembilan and Johore but, except in Pahang, the quantities were small in relation to the total obtained as can be seen from Table 2.

TABLE 2: COLLECTION AND USE OF CLONAL SEED, BY TERRITORIES

Territory	Seed collected	Seed used
Selangor	5,455,800	1,558,200
Kedah	748,690	746,890
Pahang	1,337,520	1,447,520
Negri Sembilan	153,800	490,600
Malacca	237,900	786,500
Perak	16,300	1,232,900
Johore	440,240	1,280,300
Penang/P. Wellesley	3,510	179,450
Kelantan	—	359,100
Trengganu	—	312,300
<i>Total</i>	8,393,760	8,393,760

The policy of decentralisation of clonal seedling stump production was continued and no clonal seeds were planted in the smallholders' nursery at the R.R.I. Experiment Station during 1953. Stumps grown from seeds planted in 1951 and 1952 were available from the Experiment Station and a distribution of 150,000 stumps was arranged by the Rubber Research Institute during March and April. Thereafter supplies were held against the expected demands of the R. I. (R.) B. and 111,385 stumps were available to meet their requirements in November and December.

Budwood supplies for the whole country were in considerable excess over requirements. Distribution of budwood presents a problem however and Rubber Instructors report difficulties experienced by smallholders in obtaining the material they require in quantities which can be reasonably handled while they are still fresh. Local shortages of certain clones have meant that at times clones have been used which are not best suited to the particular conditions of soil and topography. For budwood to achieve

the greatest possible popularity amongst smallholders and to be used to best advantage it is desirable that nurseries should be located throughout the country in a way which permits smallholders to obtain supplies as they require them by personally visiting the nursery. For this to be possible at least one rubber nursery is needed in every rubber growing district. The alternative is a carefully planned scheme, with the necessary facilities, for distribution from central state nurseries.

The establishment of approved high yielding planting material on smallholdings as reported by Rubber Instructors is shown in Table 3.

TABLE 3: HIGH YIELDING PLANTING MATERIAL ESTABLISHED BY SMALLHOLDERS

Territory	Clonal seedlings (acres)	Budgrafted (acres)
Selangor	1,204	82
Negri Sembilan	1,032	621
Malacca	768	277
Perak	1,247	137
Johore	819	680
Pahang	1,228	525
Kedah/Perlis	1,158	264
Penang/P. Wellesley	292	96
Kelantan	793	255
Trengganu	539	9
Total	9,080	2,946

The area recorded as planted with clonal seedlings consists of over 5,800 acres on replantings and more than 3,200 acres on new plantings. These figures may well be deficient but on experience of seed collections and clonal seedling stump production in previous years, supplies of clonal seedling stumps from official nurseries would have been expected to provide for approximately the acreage quoted.

The total area budgrafted shows a satisfactory increase on previous years. If the difference between the 1952 acreages of total planting and planting with clonal seedlings represents the area which should have been budgrafted in 1953 then over 80 per cent of budgrafting requirements have been met. The high proportion of 1952 plantings which obtained clonal seedling stumps has contributed to this result. A large increase in acreage budgrafted will however be required in 1954.

Replanting Demonstrations on Smallholdings

Fertilisers, according to requirements, have been supplied to established demonstration replantings where maintenance has been satisfactory. On many of the holdings maintenance has been below the standard necessary for satisfactory development and the use of such areas as demonstrations must be terminated if owners cannot be persuaded to undertake the necessary cultivations. One demonstration replanting ceased because Government requisitioned the land.

With the large increase in replanting in all districts of the country under the Replanting Scheme there appears to be no further need to establish formal demonstration replantings. There will, however, be a need to demonstrate new techniques which may

be discovered or to establish areas of new approved clones for early appraisal by the smallholders in their own districts. Sites for such demonstrations will be found without difficulty on smallholdings participating in the Replanting Scheme.

INVESTIGATIONS

The smallholding on the waterworks road was maintained as in previous years to enable trials of interest to the Smallholders' Advisory Service to be carried out conveniently and to provide fresh material for the divisions whenever possible. The work involves the maintenance of nurseries which are particularly of interest to the Botanical and Pathological Divisions.

We continued to take yield records from the pollarded old trees growing between hedges replanted in 1950. The yield up to July varied between 40 per cent and 25 per cent of yield of the area before replanting. In August high tapping was introduced on the pollarded trees and the yield rose to approximately 50 per cent of the original yield.

Girths of a proportion of trees in this replanting were recorded. The average girth of 103 trees at 60 inches in December was 6.0 inches compared with 4.6 inches in December 1952. This low rate of girth increase is the result of competition from the pollarded trees and in November side pruning of the old trees was undertaken to reduce shading effect on the replanted rubber. At the same time isolation trenches were reopened and filled in to sever old rubber tree roots competing with the replanted trees.

Girth measurements were again recorded in the older hedge plantings of 1948 and 1949 where the old stand has not yet been completely removed. A comparison of average girth measurements of the same samples of trees in December 1952 and December 1953 is given below:

	December 1952	December 1953	Increment
1948 double rows 3ft x 3ft (44 trees)	5.7 inches	6.6 inches	0.9 inches
1948 double rows 4ft x 4ft (67 trees)	6.8 inches	8.3 inches	1.5 inches
1949 double rows 6ft x 5ft (72 trees)	4.9 inches	6.3 inches	1.4 inches

The increments are unsatisfactorily low and steps were therefore taken towards the end of the year to eliminate two-thirds of old trees between hedges so that remaining old trees would be not less than 30ft distant from the replanted hedges.

A planting with stumped buddings in hedge formation was undertaken under the shade of old rubber with and without the pruning of branches overhanging the planting row. In another planting various treatments of the bark of stumped buddings of Tjir 1 were arranged in an attempt to improve the establishment of this clone using stumped buddings. No satisfactory economic treatment was discovered.

Advantage was taken of the need to destroy old trees on the smallholding to carry out preliminary trials of poisoning with 2,4,5-T in various formulations at varying strengths and using different systems of application. These trials gave promising results.

INFORMATION

S.H.A.S. Circular Number 3—Manuring of Replanted Rubber—an illustrated booklet containing an explanation of the need for manuring, methods of application and a standard programme for manuring average inland soils, was published in English, Malay, Chinese, and Tamil.

The series of Malay plays written by Tuan Syed Mamdooh Wafa and broadcast by Radio Malaya to illustrate technical matters of topical interest to rubber smallholders was brought to a close in June with the thirtyfifth play. 'Che Mohd Razalli took part in the 'Agricultural Forum of the Air' to answer questions on rubber growing and production. This formed part of the Malay community broadcasts and took place fortnightly throughout the year.

L. R. DAVIDSON

Smallholders' Advisory Officer

SENIOR STAFF AND GRADUATE ASSISTANTS

ADMINISTRATION

- C. E. T. Mann, M.Sc., F.I.R.I. *Director*. On leave 25 April to 13 October. (First appointed 15 June 1927)
- C. C. T. Sharp, *Deputy Director*. Died 17 March 1953. (First appointed 25 February 1931)
- C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A. *Deputy Director* from 1 December 1953. (First appointed 7 October 1930)
- H. S. Blacklin, *Secretary*. (First appointed 1 March 1932)
- J. C. Reeves, *Assistant Secretary*. (First appointed 1 September 1950)

PUBLICATIONS SECTION

- D. R. Rexworthy, B.Sc., F.R.I.C. *Publications and Information Officer*. First appointed 23 July 1952)

STATISTICS SECTION

- D. R. Westgarth, M.Sc. *Statistician*. On leave from 8 July. (First appointed 3 August 1950)
- Fong Chu Chai, R.C.D. *Assistant Statistician*. On study course in England. (First appointed 8 July 1949)
- D. K. Dutta Ray, M.A. *Assistant Statistician*. (First appointed 22 May 1952)

EXPERIMENT STATION

- R. F. Harley, M.C., A.I.S.P. *Manager*. (First appointed 27 August 1937)
- A. E. Browne, M.C., *Assistant Manager*. (First appointed 1 February 1948)
- J. E. Ellison, *Assistant*. (First appointed 10 July 1951)
- G. A. D. Hooper, *Assistant*. (First appointed 5 February 1952)

SOILS DIVISION

- C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A. *Head of Division* until 30 November. Acting *Deputy Director* from 18 March, taking over duties of *Director* from 25 April to 13 October. (First appointed 7 October 1930)
- G. Owen, M.Sc., *Head of Division* from 1 December. *Soils Chemist* until 30 November. On leave from 13 February to 22 September. Acting *Head of Division* from 23 September to 30 November. (First appointed 5 January 1939)
- E. W. Bolle-Jones, M.Sc., Ph.D., *Plant Physiologist*. (First appointed 20 August 1952)
- G. M. F. Grundy, B.Sc. *Soils Chemist* from 5 January. (First appointed 5 January 1953 after a year's study in Trinidad and England)
- (Vacant) *Soils Chemist*

BOTANICAL DIVISION

- E. D. C. Baptist, M.Sc., Ph.D., A.R.C.S., D.I.C. *Head of Division* (First appointed 20 March 1936)
- H. M. Burkill, M.A. *Botanist*. (First appointed 1 July 1948)
- C. W. Brookson, B.Sc. *Botanist*. On leave from 28 July. (First appointed 23 August 1949)
- P. de Jonge, Agr. Ir. *Botanist*. On leave from 19 December. (First appointed 29 December 1950)
- J. S. Lowe, Ph.D. *Plant Physiologist* from 11 February. (First appointed 11 February 1953)

Senior Staff and Graduate Assistants

- P. R. Wycherley, Ph.D. Botanist from 26 January. (First appointed 26 January 1953)
T. V. Vaidyanathan, B.Agric. Assistant Botanist. (First appointed 1 May 1935)
V. K. Bhaskaran Nair, M.Sc. Assistant Botanist. (First appointed 26 May 1952)

PATHOLOGICAL DIVISION

- A. Newsam, Ph.D. Head of Division. (First appointed 5 April 1947)
F. W. Hutchinson, N.D.A., C.D.A. Field Research Officer. On leave to 5 April.
(First appointed 5 March 1948)
R. N. Hilton, M.A. Pathologist. On leave to 8 September. (First appointed 7 September 1948)
R. A. Fox, B.Sc. Microbiologist. On study course in England.
K. P. John, B.A. Assistant Pathologist. (First appointed 16 November 1936)
B. Sripathi Rao, B.Sc. Assistant Entomologist. (First appointed 6 June 1952)

CHEMICAL DIVISION

- W. G. Wren, B.Sc., A.R.C.S., D.I.C., A.I.R.I. Head of Division. On leave to 3 October. (First appointed 7 January 1950)
G. W. Drake, B.Sc., M.A. Chemist. Acting Head of Division up to October. (First appointed 8 March 1948)
W. A. Southorn, Ph.D., A.R.I.C. Chemist. (First appointed 18 November 1952)
R. H. Smith, Ph.D., A.R.C.S., D.I.C. Biochemist. Resigned with effect from 5 October. (First appointed 5 October 1950)
A. S. Cook, B.Sc., A.R.I.C. Organic Chemist. On leave to 11 February. (First appointed 25 February 1949)
J. E. Morris, B.Sc. Chemist. (First appointed 20 June 1952)
H. M. Edmondson, B.Sc. Technologist. On leave from 31 August. (First appointed 28 August 1950)
R. S. Gale, B.Sc., A.C.G.I., A.M.I.Chem.E. Chemical Engineer (First appointed 2 May 1951)
D. J. Graham, Chemical Engineer from 31 March. (First appointed 31 March 1953)
L.L. Best, M.Sc., A.K.C. Technologist. (First appointed 7 March 1952)
P. F. Maher, B.Sc. Technologist from 19 June. (First appointed 19 June 1953)
D. H. Taysum, M.Sc. Microbiologist. On study course in England.
R. F. J. Freeman, Ph.D. Chemist seconded from British Rubber Producers' Research Association. (From 1 May 1952)
K. C. Sekar, B.A., A.I.R.I. Assistant Chemist. (First appointed 1 October 1928)
R. C. H. Hsia, B.Sc. Assistant Chemist. (First appointed 2 January 1953)
Cheah Sein Liat, B.Sc. Assistant Chemist. (First appointed 3 August 1948)
B. C. Sekhar, B. Sc. Assistant Chemist. On study course in U.S.A. from 16 July 1953.
(First appointed 15 September 1949)
S. J. Tata, B.Sc., Assistant Chemist. (First appointed 14 December 1953)

SMALLHOLDERS' ADVISORY SERVICE

- L. R. Davidson, B.Sc.(Agr.) Smallholders' Advisory Officer. (First appointed 1 December 1940)
J. M. F. Greenwood, B.Sc.(Agr.) Assistant Smallholders' Advisory Officer. On leave 16 February to 10 November (First appointed 25 November 1948)
J. W. L. Bevan, B.Sc.(Agr.) Assistant Smallholders' Advisory Officer. Seconded to Joint Working Party from 1 September. (First appointed 12 November 1952)

BALANCE SHEET

LIABILITIES

SUNDRY CREDITORS	\$	c	\$	c	\$	c
Staff			36,618.04			
Merchants			121,930.50			
Building Contractors			36,335.37			
Miscellaneous			69,288.66			
Malayan Rubber Fund:						
Rubber Powder Account	27,169.69					
Experiment Station Account	<u>18,437.79</u>		<u>45,607.48</u>		309,780.05	
RESERVE						
Leave Pay and Passages					330,000.00	
EXCESS OF ASSETS OVER LIABILITIES						
Balance as at 31 December 1952			1,228,733.63			
Add Interim Payment in respect of War Damage			<u>180.00</u>			
			1,228,913.63			
Less Excess of Expenditure over Income			<u>25,391.54</u>		1,203,522.09	
MALAYAN RUBBER FUND						
Grants for Capital Work under the 5 Years						
Plan covering 1949/53					2,594,912.93	

Notes: 1 Commitments on Building Contracts at 31 December 1953, not provided for in the accounts, amount to approximately \$130,000/-

2 Refunds of the Rubber Industry (Replanting) Board Replanting Cesses have been included in these accounts to the following extent:
 Schedule II — estimated refunds due for 1951 and 1952

 Schedule IV — Refunds received for period 1 July 1952 to 30 September 1953 and the estimated refund due for the last 3 months of 1953

Carried forward

4,438,215.07

ASSETS

LAND & BUILDINGS	\$	c	\$	c	\$	c
2¼ Mile Compound						
Land as at 31 December 1952	15,784.35					
198 & 200 Ampang Road:						
At Nominal Value		2.00	15,786.35			
3rd Mile Compound						
Land as at 31 December 1952	31,440.35					
251, 253, 255, 257, 259 & 261						
Ampang Road:						
At Nominal Value		6.00	31,446.35			
3¼ Mile Compound						
Land as at 31 December 1952	27,582.50					
262, 264, 266, 268 & 270 Ampang Road:						
At Nominal Value		5.00	27,587.50			
4th Mile Compound						
Land as at 31 December 1952	2,000.00					
73, 4th Mile, Ampang Road:						
At Nominal Value		1.00	2,001.00			
Eaton Road Compound						
Land as at 31 December 1952	17,147.08					
1, 3, 5 & 7 Eaton Road:						
At Nominal Value		4.00	17,151.08			
Wickham Road & Ridley Close						
Land as at 31 December 1952	43,623.50					
Nine Bungalows:						
As at 31 December 1952	\$463,571.25					
Less Over-provision at						
31 December 1952	2,030.60	461,540.65	505,164.15			
Ulu Klang						
Land as at 31 December 1952	7,705.00					
Workmen's Quarters:						
As at 31 December 1952	1.00	7,706.00				
Ampang Road						
Laboratories						
Land as at 31						
December 1952	19,526.00					
Buildings — At Nominal						
Value	1.00	19,527.00				
Additions during the year		106,228.98	125,755.98			
Sungei Buloh						
Laboratories & Houses						
As at 31 December 1952	829,460.09					
Less Interim Adjustments	29,566.33	799,893.76				
Quarters for Rubber Instructors						
Premia & Survey Fees		4,270.00	1,536,762.17			
PLANT & MACHINERY						
As at 31 December 1952:						1.00
At Nominal Value						
RUBBER POWDER PLANT & MACHINERY						
As at 31 December 1952						24,770.03
FURNITURE						
Residential Houses						
Kuala Lumpur						
As at 31 December 1952:						
At Nominal Value		1.00				
Carried forward		1.00	1,561,533.20			

Brought forward

\$4,438,215.07

Carried forward

\$4,438,215.07

		\$	c	\$	c
FURNITURE (Contd)	Brought forward		1.00	1,561,533.20	
Sungei Buloh					
As at 31 December 1952					
At Nominal Value			1.00		
Offices					
Kuala Lumpur					
As at 31 December 1952					
At Nominal Value			1.00		
Library					
As at 31 December 1952					
At Nominal Value			1.00		
Laboratories					
As at 31 December 1952					
At Nominal Value:					
Kuala Lumpur			1.00		
Sungei Buloh			1.00	6.00	
APPARATUS & GLASSWARE					
As at 31 December 1952					
At Nominal Value				1.00	
MOTOR VEHICLES					
As at 31 December 1952					
At Nominal Value				1.00	
WORKSHOPS					
As at 31 December 1952					
At Nominal Value				1.00	
LIBRARY BOOKS & PERIODICALS					
As at 31 December 1952					
At Nominal Value				1.00	
EXPERIMENT STATION DEVELOPMENT					
As at 31 December 1952		943,449.23			
Additions during the year		210,158.73			
		<u>1,153,607.96</u>			
Factory—As at 31 December 1952		422,635.66		1,576,243.62	
STOCKS					
Petrol, Oil & Chemicals					
Head Office	383.67				
Experiment Station	<u>14,848.54</u>	15,232.21			
Empty Drums & Containers					
Head Office	515.00				
Experiment Station	<u>280.00</u>	795.00			
Stationery					
Head Office		6,789.29			
Sundry Materials					
Head Office	8,372.99				
Experiment Station	<u>13,972.72</u>	22,345.71			
Rubber					
Experiment Station		<u>20,065.55</u>		65,227.76	
SUNDRY DEPOSITS				170.00	
SUNDRY DEBTORS					
Staff					
Loans for Motor Vehicle Purchase	235,879.31				
Travelling & Leave Advances	<u>23,966.07</u>	259,845.38			
Carried forward		<u>259,845.38</u>		<u>3,203,184.58</u>	

Brought forward

\$4,438,215.07

\$4,438,215.07

REPORT OF THE AUDITORS TO THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

We have examined the above Balance Sheet dated 31 December 1953 with books and vouchers and explanations we have required.

In our opinion, such Balance Sheet is properly drawn up so as to exhibit a true and correct statement of the assets and liabilities given to us and as shown by the books of the Institute.

Kuala Lumpur
26 March 1954

	Brought forward	\$259,845.38	\$3,203,184.58
SUNDRY DEBTORS (Contd)			
General			
Head office	93,137.11		
Experiment Station	<u>4,233.92</u>	97,371.03	
Interest Accrued on Investments		2,729.97	
Payments in Advance		22,016.48	
Rubber Industry (Replanting) Board			
Replanting Cesses		<u>67,693.95</u>	449,656.81
INVESTMENTS			
\$15,000/—4½% Singapore Municipal Debenture Stock 1930-70/80:			
As at 31 December 1952		15,000.00	
(\$17,537/-*) (\$14,474/-†)			
\$40,000/—3% F.M.S. Govt. War Loan 1940-52/59			
As at 31 December 1952		40,000.00	
(\$40,000/-*) (\$38,400/-†)			
\$160,000/—3% Malayan Union Govt. Loan 1946-62/66			
As at 31 December 1952		<u>160,000.00</u>	215,000.00
(\$160,000/-*) (\$130,996/-†)			
(\$217,537/-*) (\$183,870/-†)			
* Original Cost			
† Market Value as at 31 December 1953			
CASH AT BANK & IN HAND			
Chartered Bank, London		1,045.07	
Chartered Bank, Kuala Lumpur		563,136.97	
In Hand		<u>6,191.64</u>	570,373.68
			<u>\$4,438,215.07</u>

the Rubber Research Institute of Malaya and report that we have obtained all the information of the state of the Institute's affairs according to the best of our information and the explanations

Sgd Peat, Marwick, Mitchell & Co.
Chartered Accountants
Auditors

EXPENDITURE

To	\$ c
Board & Committee (Fee & Expenses)	3,657.50
London Advisory Committee:	
Contribution for Research	109,714.60
International Rubber Research Board & Development—Contribution for Research	5,530.99
Salaries & Allowances	1,255,112.41
Gratuities	39,629.60
Provident Fund Contributions	121,020.61
Leave Pay & Passages	185,906.34
Medical	18,084.59
Recruiting	3,538.66
Travelling	69,449.61
Printing, Stationery, Postage, Telephone, Audit & Legal	40,043.53
Rents, Rates & Taxes	12,348.90
Insurance	41,569.18
Maintenance of Laboratories & Houses	57,739.68
Maintenance of Grounds	4,785.84
Furniture & Office Equipment	31,492.43
Fixtures & Fittings	10,479.35
Power, Light, Water & Sanitation	54,305.61
Plant & Machinery — Repairs & Running (excluding Power)	13,991.88
Workshop	5,962.50
Apparatus & Glassware	123,254.08
Motor Vehicle Running Expenses less Proceeds of Vehicle Sold	13,709.97
Chemicals	18,166.40
Publications	34,374.59
Library—New Books, Periodicals & Sundries	13,673.68
Exhibitions & Conferences	7,521.05
Smallholders' Advisory Service	513,415.84
Experiments:	
Field & Testing Laboratories	127,762.14
Technical Classification of Rubber	69,035.79
	<u>3,005,277.35</u>

Income & Expenditure Account for Experiments

To	
Revenue Expenditure	576,898.11
Excess of Income over Expenditure	18,437.79
	<u>595,335.90</u>

tion) for the year ended 31 December 1953

INCOME

By	\$	c
Malayan Rubber Fund	2,919,659.00	
Publications Sold	11,317.24	
Rents on Houses	16,002.01	
Interest on Loans	4,002.96	
Interest on Investments	6,674.16	
Miscellaneous	22,230.44	
Balance being Excess of Expenditure over Income	25,391.54	

3,005,277.35

tion for year ended 31 December 1953

By

Sales & Stock of Rubber	467,154.14
Sales of Planting Materials	16,877.60
Rubber Industry (Replanting) Board	
Refund on account of Replanting Cesses	111,304.16
	\$595,335.90

